PB-250 850

CARBON MONOXIDE MEASUREMENTS IN THE VICINITY OF SPORTS STADIUMS

W. D. Bach, et al

Research Triangle Institute

Prepared for:

Air Pollution Technical Information Center

July 1973

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082206
APTIC #
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EPA-450/3-74/049
JULY 1973
PB 250 850

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SPRINGFIELD, VA. 22161

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-450/3-74-049		

4. TITLE AND SUBTITLE	5. REPORT DATE
Carbon Monoxide Measurements in the Vicinity of Sports Stadiums	July 1973
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO
Bach, W.D., B.W. Crissman, C.E. Decker, J.W. Minear, P.P. Rasberry and J.B. Tommerdahl	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
Research Triangle Institute Research Triangle Park, N.C. 27711	2AC 129
	11. CONTRACT/GRANT NO.
	68-02-1096 Task No. 1
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
U.S. Environmental Protection Agency Office of Air Quality Planning and Standards Monitoring and Data Analysis Division Research Triangle Park, N.C. 27711	Final June-July 1973
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

Monitoring studies of ambient CO concentrations in the vicinity of major league baseball stadiums in Pittsburgh and Atlanta were conducted for approximately 1 week in each location. Wind speed and direction were also recorded on the site. Traffic was monitored for 1-hour periods before and after games. Grab samples of CO were also obtained during the one hour periods before and after games. No violations of the 1-hour National Ambient Air Quality Standard for CO were observed. Highest concentration occurred immediately after the games. Traffic was observed to clear out within about 30 minutes after a game. Some of the data suggest that a less efficient system of traffic controls may result in violations of the 1-hour National Ambient Air Quality Standard in certain locations.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution, Parking Facilities, Exhaust Emissions, Micro Meteorology Traffic Surveys	Indirect Sources Ambient CO Concentrations Air Quality Monitoring	13/02

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
Unlimited	UNCLASSIFIED	99
	20. SECURITY CLASS (This page)	22. PRICE
	UNCLASSIFIED	5.00 - 2.25

EPA Form 2220-1 (9-73)

APTIC # 75057

EPA-450/3-74-049

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Contract No. 68-02-1096
Task No. 1
Program Element No. 2AC129

EPA Project Officer: Edwin L. Meyer, Jr.

Prepared for

ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, N. C. 27711

July 1973

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Publication No. EPA-450/3-74-049

ACKNOWLEDGEMENTS

RTI wishes to acknowledge the cooperation of the staff and personnel of Three Rivers Stadium, Pittsburgh, and Atlanta Stadium. In particular, we wish to thank Mr. Charles Portman, Executive Director of Three Rivers Stadium Authority; Mr. Charles McSwigan, Jr., Operations Manager at Three Rivers Stadium; Mr. Sidney Scarborough, Executive Secretary, Atlanta Stadium Authority; and Mr. Joe Shirley, Operations Manager, Atlanta Stadium. Their cooperation and counsel made our job easier and more productive.

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1.0 INTRODUCTION

1.1 Purpose and Objective

In order to obtain background data which could be useful for gauging the impact of proposed sports complexes on ambient air quality, the Monitoring and Data Analysis Division of the Environmental Protection Agency (EPA) requested that the Research Triangle Institute (RTI) perform two short-term studies to determine the contribution of sports stadiums to ambient carbon monoxide (CO) concentrations. To identify possible terrain effects, one study was conducted in an area of essentially flat terrain (Atlanta) with the other in a valley (Pittsburgh). The objective of the study was to obtain CO concentrations and attendant meteorological data at these sports stadiums over a period of several days when ball games were played.

1.2 Method of Approach

To meet the study objective, RTI proposed a plan to continuously monitor carbon monoxide at three sites about each stadium complex; obtain and analyze grab samples of ambient air just prior to and after each ballgame; obtain traffic flow and traffic count data; determine the length of time for randomly selected vehicles to enter and exit parking lots; and to measure meteorological variables pertinent to the study.

To accomplish the tasks set forth, EPA provided six CO analyzer systems (a CO analyzer and a pump/dryer), four strip chart recorders, two 20-foot AVION trailers, and one Dodge motorized van for transport of the equipment and housing for continuous monitoring instrumentation. RTI provided the necessary field personnel and other equipment to accomplish the goals.

The study plan called for monitoring during three baseball games (2 night, 1 day) in Pittsburgh in three days, June 22 through 24, and for eight games — four night games, a daytime double-header, and an evening double-header — in six days, June 30 through July 5, in Atlanta.

2.0 CARBON MONOXIDE MEASUREMENTS

Carbon monoxide was continuously monitored using Mine Safety Appliance Model 202 Non-Despersive Infrared (NDIR) Analyzers. Operation, maintenance and calibration procedures specified by the Quality Assurance and Environmental Monitoring Laboratory Division, Environmental Protection Agency were adhered to. A block diagram depicting the MSA NDIR analyzer and the data display system utilized in this study is shown in Figure 1.

Analyzers and associated equipment were housed in environmentally controlled shelters (i.e. 2 AVION trailers and a Dodge Camper).

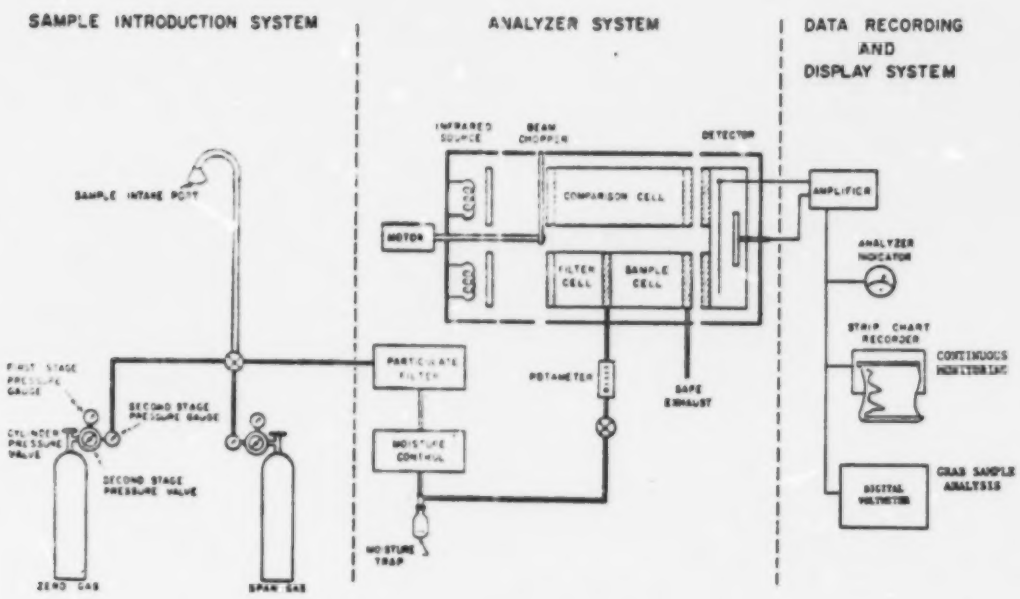


Fig. 1. Sampling, analysis and data recording system.

3.0 DATA ACQUISITION

The sampling program in both cities consisted of four main parts:

1) Continuous monitoring of ambient CO concentrations at three sites.
2) Collection of 15 minute grab samples at four locations within the parking lot stadium complex before and after each game.
3) Counting of vehicular traffic before and after the game with representative ingress and egress times for selected cars and people.
4) Continuous monitoring of wind speed and direction with unscheduled measurements of ambient temperature and relative humidity.

3.1 Continuous Monitoring

3.1.1 Site Selection and Description

Three continuous monitoring sites were chosen in the vicinity of the stadium complex in both Pittsburgh and Atlanta. The primary criterion was to locate the sites approximately in a straight line along the axis of the anticipated prevailing wind to define the ambient concentration upwind and downwind of the stadium area and, thereby, to indicate the contribution of the stadium and the associated activities to background CO concentrations. By coincidence the resulting configuration lay along the major axis of the parking lot-stadium complex in both cities. Availability of space to park the trailers, electrical power for the stations and demography of the area also influenced the site selections.

Pittsburgh

Three Rivers Stadium stands along the north bank of the Allegheny River at its point of confluence with the Monongahela River to form the Ohio River. Immediately to the north of the stadium a bluff rises three to four hundred feet as does the topography along the south bank of the Ohio River. A study of the wind speed and direction, prior to the construction of the stadium, showed a prevailing westerly wind direction up the river valley, with speeds greater than observed at Greater Pittsburgh Airport occurring 17 percent of the time with the average speed increase of 4 miles per hour.[1] Figure 2 shows a plan view of the immediate vicinity of the stadium, the location of the sampling sites, and the traffic flow. Representative photographs of these sites are shown in Figure 3.

Station C1, located to the west of the stadium, is relatively free of obstruction to the prevailing up-river air flow. Station C2, just to the south of the stadium served as the base of operations. Although, proximity to the stadium structure influenced the air flow and CO concentration there, it appeared less influenced than other possible near-stadium sites. Station C3 to the east, except for the stadium, had few major obstructions to up-river flow. However, a one-story building forty feet east of it perturbed the predominantly down-wind air flow to some extent.

The flow of automotive traffic about the stadium is almost exclusively in a counter clockwise manner. Consequently, station C1 is relatively unaffected by traffic, C2 is affected more than C1

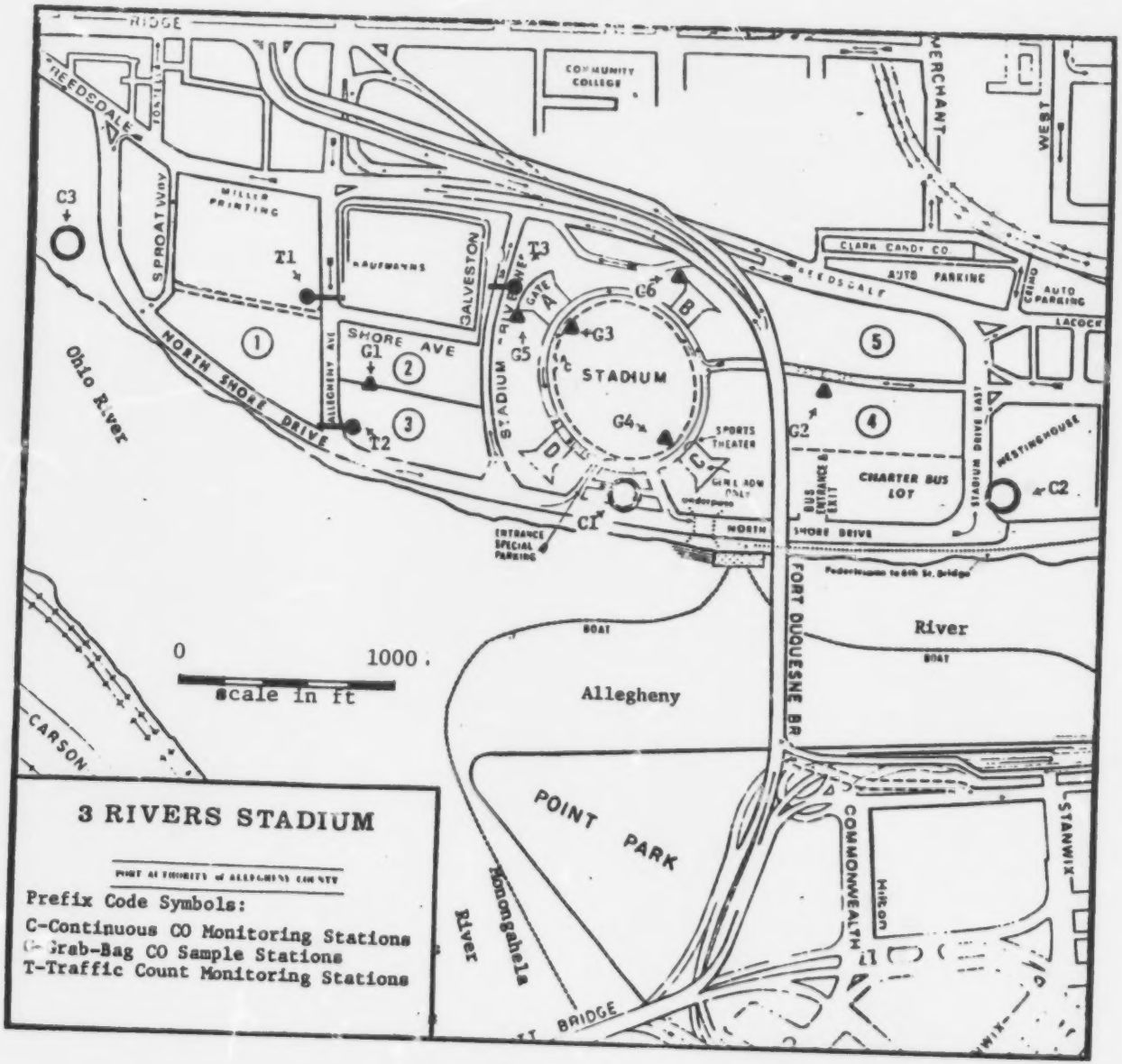
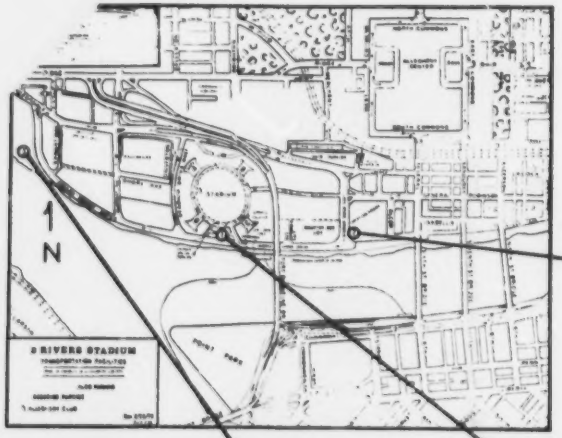


Fig. 2. Pittsburgh location map.

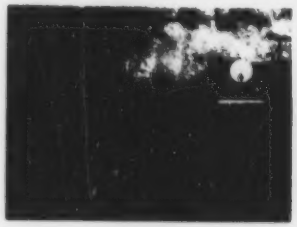


PITTSBURGH STADIUM

Location Map, Sampling Sites and Reduced Strip Charts

LOOKING WEST

LOOKING NORTHEAST



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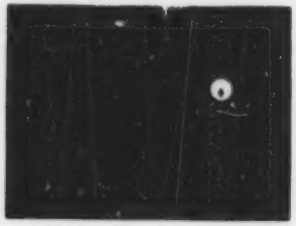

LOOKING WEST

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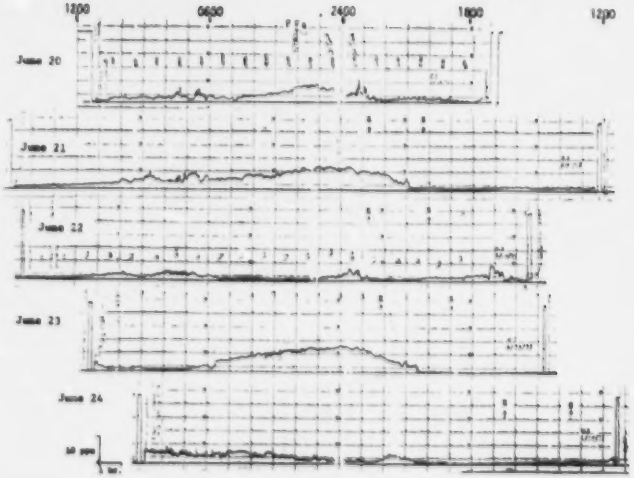
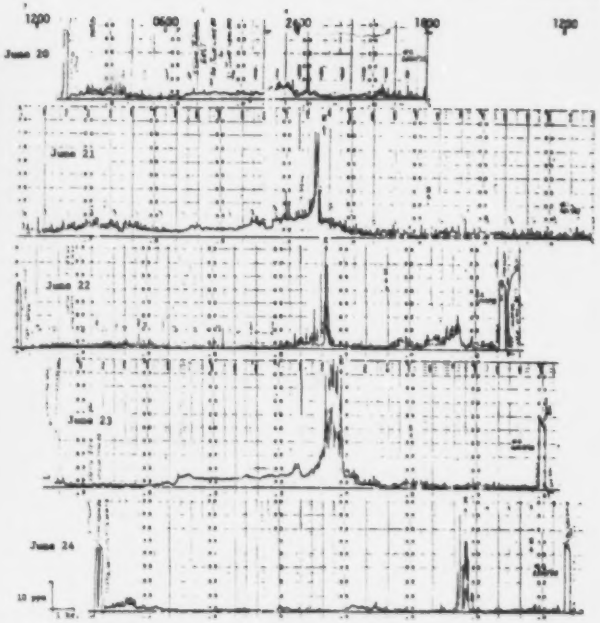
LOOKING EAST





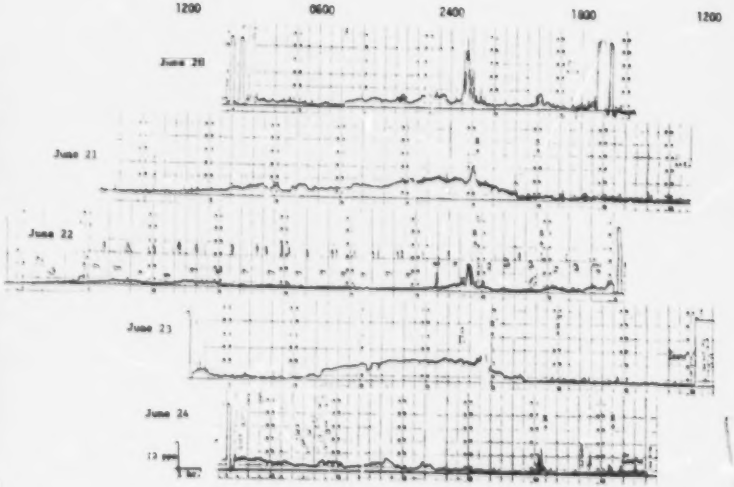


Fig. 3. Location map, site pictures, and reduced strip charts; Pittsburgh Stadium.

but less than at C3 where almost all traffic must pass and stop intermittently for a traffic light.

Atlanta

The Atlanta stadium is situated in an area of old one-and two-story homes and buildings. The land slopes from north to south, falling about 50 feet between Fulton Street and Georgia Avenue with lesser slopes east and west of Capitol Avenue (See Figure 4). Topography influences the wind flow region about Atlanta Stadium minimally. Southwest winds occur in Atlanta during July more frequently than any other direction but westerly and easterly winds are common.[2] Continuous monitoring stations were placed in private parking lots to the southwest and northeast of the stadium and in a central location east of the stadium but in the stadium-operated parking lots (See Figures 4 and 5).

Traffic flow on the streets about the Atlanta Stadium area is normally local two-way traffic. Capitol Avenue and Georgia Avenue are principal north-south and east-west thoroughfares, respectively, for local traffic. The expressways north and west of the stadium (see Figure 7) carry the principal through traffic and the downtown-suburbs traffic.

3.1.2 CO Analyzer Setup

Each continuous monitoring site was equipped with two CO analyzers, two pump/dryers and at least one strip-chart recorder. For routine operations in the trailer stations, both analyzers were turned on, but only one pump/dryer was operated. In this configuration, the spare analyzer was warmed up (the initial warm up requiring from

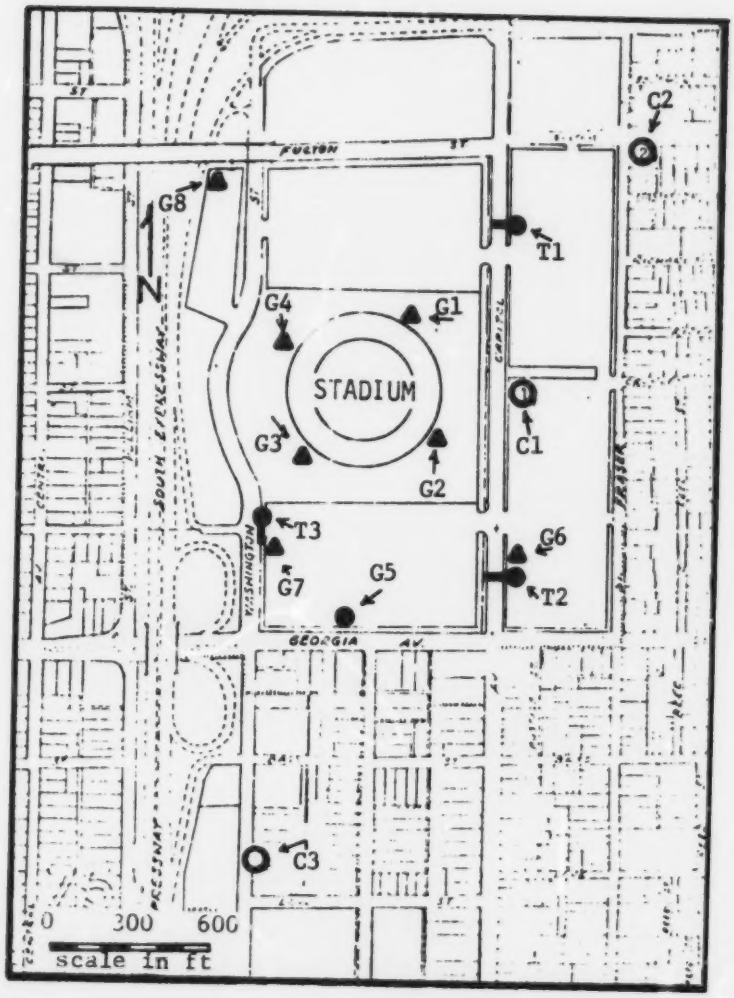


Fig. 4. Atlanta Stadium location map.

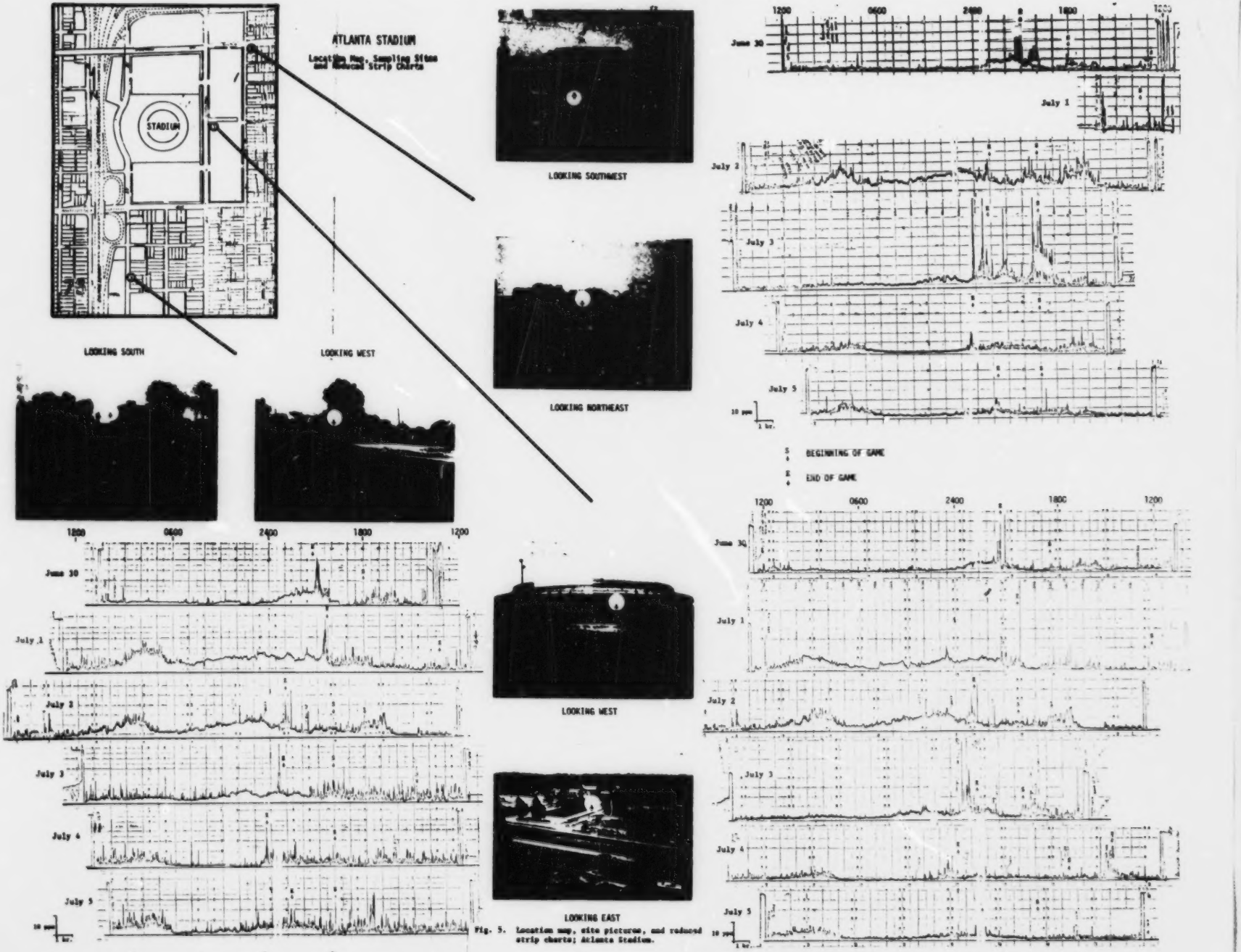


Fig. 5. Location map, site pictures, and reduced strip charts; Atlanta Stadium.

12 to 24 hours) and readily available if any difficulties arose with the online analyzer. Parallel operations of two analyzers sampling the same air were not feasible at all sites since only four strip chart recorders were available.

Ambient air was drawn into the analyzer system through an inverted plastic funnel approximately three feet above the trailer top (12 ft above ground) which was connected to the pump/dryer with polyethylene tubing (0.125 in ID) about 15 feet in length.

At the central location at each stadium, both of the analyzer systems were operated. One analyzer was designated for continuous monitoring and the second for grab sample analysis. Ambient air for the continuous monitoring instrument was drawn through an inverted glass funnel about 10 feet above the ground (~6 inches above the roof line of the vehicle) by a blower unit into a one-inch ID glass manifold about three feet in length. Polyethylene tubing (0.125 in ID) was used to connect the pump of the analyzer to this manifold.

In Pittsburgh, the grab sample analyzer was connected to the spare strip chart recorder and operated in parallel with the other unit when grab samples were not being analyzed. Ambient air was drawn from the same manifold. Differences in the strip chart records of the two analyzers noted during these periods were less than 0.5 ppm.

In Atlanta, the spare strip chart recorder was used at the trailer locations. Consequently, a strip chart comparison of the two analyzers at the central location was not made. On occasions,

the grab bag analyzer system was connected to the intake manifold and the output voltages read on a digital voltmeter for comparison with those from the continuous analyzer. Differences were always less than .5 ppm and generally negligible.

In Atlanta parallel operation of the two analyzers at C3 was initiated soon after arrival. Two days of data showed the primary analyzer reading significantly lower than the spare. A sample of zero and span gas was analyzed by both systems and by the grab sample analyzer located at C1. The spare unit and the grab sample unit agreed. Thus, the spare unit was designated as the primary unit and used at C3 for the remainder of the Atlanta survey. For the duration of the study the analyzer appeared to function normally.

The primary analyzer at C2 began exhibiting a square wave pattern with a 30-to 40-minute period soon after Atlanta operations began. The spare was placed in parallel operation after the extra strip chart recorder became available and that configuration continued through the study. The spare functioned well and was designated as primary. The square wave appeared and disappeared from time to time on the strip chart of the malfunctioning unit.

3.1.3 Calibration Procedures

Upon arrival at a site, all analyzers were turned on and left to run and stabilize for 18 to 24 hours before a calibration was made. Thereafter, the trailer units were calibrated daily when a zero and span were performed on the active units according to established calibration procedures and the strip chart record was removed for analysis. Visual checks for proper operation of the instruments were made each day.

Additional calibration checks on the central station analyzers were made.

Span and zero point drift statistics are given in Appendix D for the five analyzers used in continuous monitoring.

3.1.4 Span and Zero Gas Checks

Zero and span gases were obtained from Scott Research Laboratories on June 15, 1973 for calibration of the analyzers. One cylinder of zero and span gas was provided at each of the three continuous monitoring sites. An independent check of the span gases and one zero gas was made prior to the Atlanta study at RTI using a Beckman 6800 Gas Chromatography CO analyzer using zero and span gases certified to contain < .1 ppm and 95.9 ppm $\pm$ 2% ppm CO. The technician performing the tests was unaware of the sample concentrations.

The results of this check are summarized in Table I and show that there was no significant difference from the concentration as specified by the manufacturer.

Table I. COMPARATIVE ANALYSIS OF CO CALIBRATION GASES

Cylinder Number	Manufacturer Analyses	Analyses at RTI 25 June 1973
MH-1755	25.4 ppm $\pm$ 2%	25.14 ppm
MH-1317	25.7 ppm $\pm$ 2%	25.94 ppm
A-3576	24.9 ppm $\pm$ 2%	25.21 ppm
A-11782	<0.5 ppm $\pm$ 2%	N/A
A-6693	<0.5 ppm $\pm$ 2%	N/A
A-8338	<0.5 ppm $\pm$ 2%	-0.05 ppm

3.2 Grab Samples

3.2.1 Sampling Plan

Grab samples were taken for five 15-minute periods beginning one hour before each ballgame and for five 15-minute periods beginning at the end of the game. For the two "double-header" games in Atlanta an additional 15-minute sample was made at the completion of the first game.

3.2.2 Site Locations

Grab sample sites were chosen to satisfy as many of the following criteria as possible:

1) Obtain samples in the vicinity of major exits and entrances to parking lots;
2) Obtain samples in areas in and outside the stadium where people may congregate;
3) Give as extensive coverage as possible to the statium area;
4) Provide an advantageous position to perform other duties.

In Pittsburgh, grab sampling was carried out at the six locations shown in Figure 2. Throughout the period (June 21 to June 24) locations G1 and G2 remained unchanged. Position G3 was in a sheltered area behind the second tier of seats in the stadium, 25 feet from a concession area. G4 was in the upper deck of the center field seats. Those two positions were chosen to examine contrasts within the stadium. These locations were changed to G5 and G6 at game's end on June 22, to better conform to the objectives of the grab sample program.

The eight sampling locations around Atlanta Stadium are identified in Figure 4. Locations G1 to G4 , in the vicinity of ticket booths

on the outer perimeter of the stadium proper, were well exposed (see Figure 6). Beginning with the game on July 3, the locations were changed to G5 to G8 which are more closely associated with major traffic arteries. Representative grab sample sites are shown in Figures 6 and 7.

3.2.3 Apparatus

The grab sample apparatus used for this study is shown in Figure 6. Ambient air is drawn into a foot operated bellows-like pump through a 0.125 inch ID polyethylene tube. The air is then forced into a Tedlar bag of approximately 30-liters capacity through a shorter length of the same type of tubing. Check valves placed in the intake and output connections to the pump prevent recycling of the same air. The pressure drop through the intake tube regulated the intake flow rate so that 25 seconds was required to fill the bellows. At a rate of about two pumps per minute, the bags could be completely inflated in 15 minutes. The intake tube was taped to available support at a height of four to seven feet above the ground.

Five bags were placed in a two-foot cube cardboard box for protection. When full, each bag was labeled to indicate the site number, the sample number and the time that the sample began. Screw-lock values on the Tedlar bags were closed to seal the bag.

3.2.4 Analysis

Upon completion of the sampling period, the samples were returned to the central station for analysis. Following the completion of the games, an interim pick up of the bags would usually be made by an available person to shorten the time reuqired to complete analysis. All of the samples were analyzed within three hours after they were taken.

Grab Sample Site G6 at
Pittsburgh Stadium

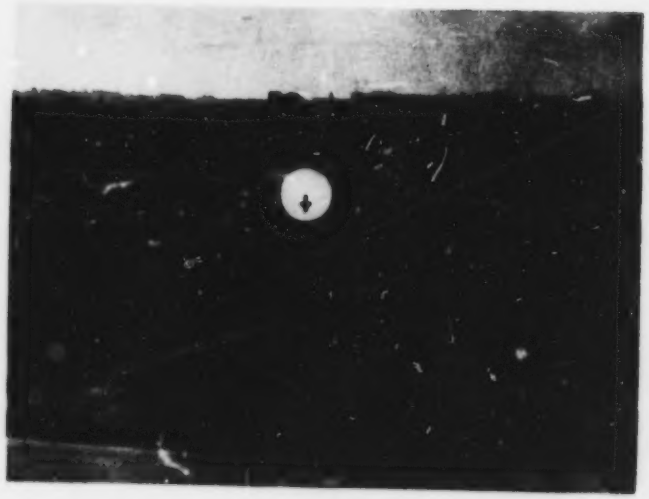
Grab Sample Site G2 at Atlanta Stadium

Grab Sample Site G6 at Atlanta Stadium

Grab Sample Site G1 at
Pittsburgh Stadium

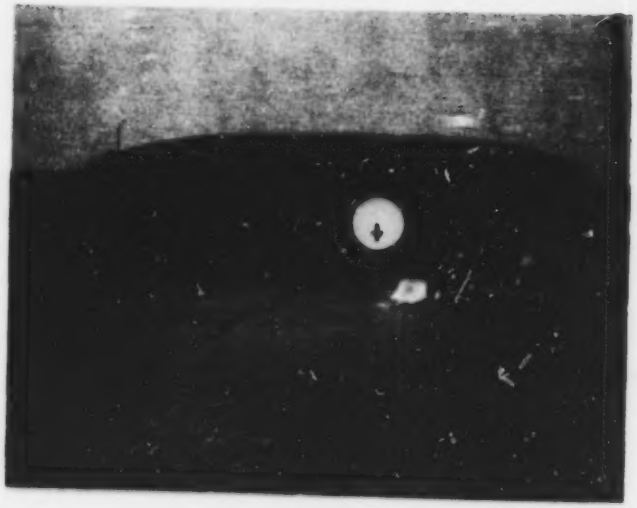
Fig. 6. Grab sample locations

Typical Arrangement of Analyzers in Trailers



Grab Sample Site G8 at Atlanta Stadium

Grab Sample Site G7 at Atlanta Stadium



Grab Sample Site G2 at Pittsburgh Stadium

Fig. 7. Grab sample locations and CO analyzer setup

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Some modifications were made to the pump/dryer system to shorten the time required for analysis of the grab samples. After some experimentation and assurance that the pump/dryer was operating effectively, the water trap was removed for grab-sample analyses only. This reduced the time required to purge the analyzer system and shortened the response and stabilization times of the analyzer to a new sample.

A digital voltmeter (DVM) was attached in parallel with the strip chart recorder to get a digital display of the output voltages (in Atlanta only the DVM was used). The zero gas calibration was set at + 1.0 mv. With the span gas and analyzer settings used, one mv on the DVM corresponded to .5 ppm CO. The analyzer was calibrated one to two hours pregame and an unadjusted zero and span was performed immediately after all grab samples were analyzed. There was negligible drift in span and zero points (see Calibration Record in Appendix C).

With this configuration, the grab sample analysis proceeded as follows:

1) Remove bag label and record on the Grab Sample Analysis Sheet.
2) Connect (via a five-foot polyethylene tube with a screw valve attachment) the bag to the pump with control valves in the SAMPLE position.
3) Allow 2 to 3 minutes for analyzer output to stabilize.
4) Observe the DVM for one minute and record the eyeball average.
5) Set dryer/pump control values to CALIBRATE position and evacuate the bag. Air flow is much greater in the CALIBRATE position.

6) Disconnect bag, closing the valve on the bag.

7) Reset valves to SAMPLE position.

After the two-to three-minute stabilization period for the grab bags, the DVM output fluctuated less than .5 mv over the next minute of observation. This corresponds to a CO concentration fluctuation of less than .25 ppm, which is within the limits of the CO analyzer accuracy.

Grab Bag Experiments

The grab bags were reused after being exhausted. Before adopting this procedure, a bag was filled with span gas and analyzed using the grab sample analysis procedure. The bag was reinflated with zero gas and the procedure repeated. No trace of the span gas could be identified indicating that the exhausting procedure was sufficient to prevent sample contamination.

Four experiments were conducted to investigate the possibility that the sample might deteriorate between the times of its acquisition and analysis. The results of those experiments, set forth in Table II, showed no deterioration of the samples.

Table II. GRAB SAMPLE DETERIORATION EXPERIMENTS

Experiment	Date	Time	Type	DVM Reading
1	6/21/73	1230	Ambient	2.8 mv
	6/22/73	1335		2.6 mv
2	6/21/73	1235	Ambient	3.1 mv
	6/22/73	1340		3.1 mv
3	7/4/73	0015	Mixture of Zero and Span	20.6 mv
	7/4/73	2135		19.0 mv
	7/5/73	0200		19.0 mv
4	7/4/73	0120	Ambient	73.2 mv
	7/4/73	2130		72.3 mv
	7/5/73	0155		72.3 mv

3.3 Traffic Counting

Traffic counting was accomplished using hand counters and pneumatic vehicle-activated counters on the streets. The counting plan varied with the traffic patterns in each city and evolved by trial and error. In both cities, before a game, the parking lots filled slowly over a two- to three-hour period, but more rapidly near game time. Within thirty to forty minutes following a game, the lots were practically empty.

Total cars parked in the main stadium lots, areal extent of the lots, and attendance for the ballgames at Pittsburgh and Atlanta are given in Table III.

Table III. ATTENDANCE AND TOTAL NUMBER OF CARS IN STADIUM PARKING LOTS

PITTSBURGH			ATLANTA		
	ATTENDANCE	CARS		ATTENDANCE	CARS
June 21	10,099	1421	June 30	17,333	3067
June 22	21,129	2226	July 1	18,450	3602
June 23	24,399	2858	July 2	6,950	1765
June 24	20,000	2182	July 3	22,894	3618
			July 4	13,500	3139
			July 5	5,340	1791

Total Area of Pittsburgh Stadium Lots is 1,349,400 ft^2

Total Area of Atlanta Stadium Lots is 1,523,200 ft^2

Pittsburgh

The traffic flow around Three Rivers Stadium does not change when an event is scheduled. Generally, all of the traffic south of Reedsdale (east-west street just north of the stadium, in Figure 2) is related to the stadium. The entrance to Parking Lots 1, 2 and 3 are all from Allegheny

Avenue between Shore Drive and North Shore Drive. The entrance to Lot 4 is from North Shore Drive while access to Lot 5 is from Reedsdale. The usual pattern is for Lots 2 and 3 to fill first followed by Lots 1, 5, and finally, 4. Public buses enter and leave through the roadway shown as "PAT BUSES" which encircles the stadium.

Entrances also function as exits. Additional exits are: Lot 1 onto Sproat Way; Lot 2 onto Stadium Drive West; and Lot 5 near the east end onto Reedsdale.

For the first two days, personnel operating at G1, counted traffic coming into Lots 2 and 3, all of which had to pass him. Later, pneumatic traffic counters were placed across Allegheny Avenue north of Shore Drive (T1) and just north of North Shore Drive (T2). These counters were read at 10-to 15-minute intervals. Traffic on Stadium Drive West was hand counted from position G5 (T3).

Traffic into and out of Lot 5 was hand counted by the man at G2. However, his visibility was often restricted by the passing buses and his counts were admittedly inaccurate. After sampling at G6 was initiated, traffic counting was transferred to this site.

The pneumatic counters were found to be inaccurate in counting very slow moving traffic. Adjustments and repairs were necessary during the study.

Atlanta

The primary entrances and exits to the parking lots around the stadium are located on both sides of Capitol Avenue (see Figure 4). Secondary entrances to the south parking lot are from Washington Street on the west and Georgia Avenue on the south. The former is a primary exit for that lot. Although the lots east of Capitol Avenue have exits to

Frazer Street, those remained closed during all of the games. A secondary exit to the northeast lot onto Fulton Street was open after the games.

For about 90 minutes before a game began, Capitol Avenue was designated as one-way, southbound. Placing pneumatic counters north and south of the parking lot entrances permitted a "net cars parked" computation. After the game, cars leaving the northern lots on Capitol were routed north and those leaving the south routed southbound. A net loss of cars could be computed assuming there was no two-way traffic.

Cars entering and leaving the south parking lot via Washington Street were manually counted by the man at G3 and later at G7.

3.4 Meteorological Data

Wind speed and direction were continuously measured at both cities using a Climet three-cup anemometer and independent wind vane. Before going into the field, the system was checked out and calibrated in the laboratory. The instruments were mounted on a tee which separated them by about 4 feet. Anemometer heights were 21 feet (Figure 3) and 12 feet (Figure 5) at Pittsburgh and Atlanta, respectively.

The wind system was installed at the central location so that it could be routinely observed. Undoubtedly, the nearness of the system to the stadiums affected the wind measurements, but that appeared unavoidable. These wind data and comparisons with airport winds are discussed in Section 4.0. A strip chart recording of the speed and direction was made. The average speed and direction for the 10 minutes prior to each hour was digitized from the strip chart records. This practice roughly

conforms to the standard wind reporting practice of first-order weather stations.

At random intervals, measurements of wet and dry bulb temperature were made, approximately six feet above the ground, with a Bendix Psychrotron. When appropriate, remarks upon prevailing weather conditions were recorded. These measurements and comments are presented in Table IV.

Table IV. METEOROLOGICAL OBSERVATIONS, PITTSBURGH

Date	Time	Temperature (°F)	Wet bulb temperature (°F)	Relative humidity (percent)	Wind Direction	Wind Speed (mph)	Comments
6/21/73	1400	78.6	71.5	70	W	5	
	1800	81.2	68.3	52	NW	7	
6/22/73	0145	69.0	66.2	88	NW	3	
	1345	80.0	65.4	45	WNW	10	Good visibility
	1610	77.0	64.2	50	NW	11	Broken Cirrus Light thundershower ended 1630
	2130	72.0	64.5	67	VRBL	2	Lightning to SE
6/23/73	0015	72.0	64.2	66	NW	3	
	1810	85.2	64.4	31			
	1950	79.5	64.0	42	WNW	8	
6/24/73	0030	69.2	64.1	76	NW	5	
		Light rainshower before 1000					
	1400	78.1	66.0	52	VRBL	<3	Light shower 1422
	1800	79.2	66.2	50	NNW	10G 15	Light thundershower

Table IV. METEOROLOGICAL OBSERVATIONS, ATLANTA

Date	Time	Temperature (°F)	Wet bulb temperature (°F)	Relative humidity (percent)	Direction	Speed (mph)	Comments
6/30/73	1020	79.2	68.6	58	CALM		
	1515	90.0	69.0	32			
	2030	83.0	68.0	46			
7/1/73	1100	80.5	69.2	56	SW		Scattered clouds
	1420	90.0	69.5	34			
	2200	81.2	69.5	54	N		
7/2/73	1445	93.2	72.2	34			Light rain shower 1600-1645
	2140	82.0	72.0	61	CALM		
7/3/73	0025	78.0	72.0	74	CALM		Fog forming (later dissipated)
	1405	92.0	73.5	41	SW	8	Hazy
7/4/73	1620	88.5	78.0	62	N	5	Light shower began 1530 ended 1640
	2120	82.0	72.3	62	N	8	Lightning east and south
	2255	80.5	73.0	70	NNE	5	
7/5/73	0125	77.2	71.5	75	SSW	10	Occasional lightning
	1330	80.5	71.5	64	NNW	3	Overcast ~12Kft

4.0 DISCUSSION OF RESULTS

For the entire study only 24 of 745 hours of continuous monitoring data were lost due to instrument calibration or malfunction. This is a 96.5 percent data recovery rate and more hours of continuous monitoring than were proposed. Of a possible 408 grab samples of air, 400 were taken and 394 (96.6 percent) were analyzed. Only 368 samples were scheduled. A temporary malfunction of a strip chart recorder negated the analysis of six samples. All wind data taken on-site were retrieved in addition to copies of the hourly weather observations at the local airports. Traffic data were taken but with somewhat limited success.

4.1 Pittsburgh

4.1.1 Continuous Monitoring

The strip chart records at the three locations (Figure 3) and the plotted hourly average concentrations (Figure 8) show a general pattern of very low ($\leq$ 2 ppm) CO concentrations during the daytime at all locations. On three of the five nights the CO concentration began increasing at 2100 hours (before the end of any of the night games) reaching a maximum value at Midnight and slowly decreasing until near sunrise. This trend is most apparent in the strip chart records of location C3, but is present in equal magnitude at the other two locations. There is also some suggestion that on Sunday night, June 24-25, a similar pattern tried unsuccessfully to develop.

A plausible hypothesis for the observed trend of CO concentration may be as follows:

> Near sunset (~ 2100), radiational cooling along the ridges above the river valley causes the air to sink toward the floor of the valley, bringing CO with it.

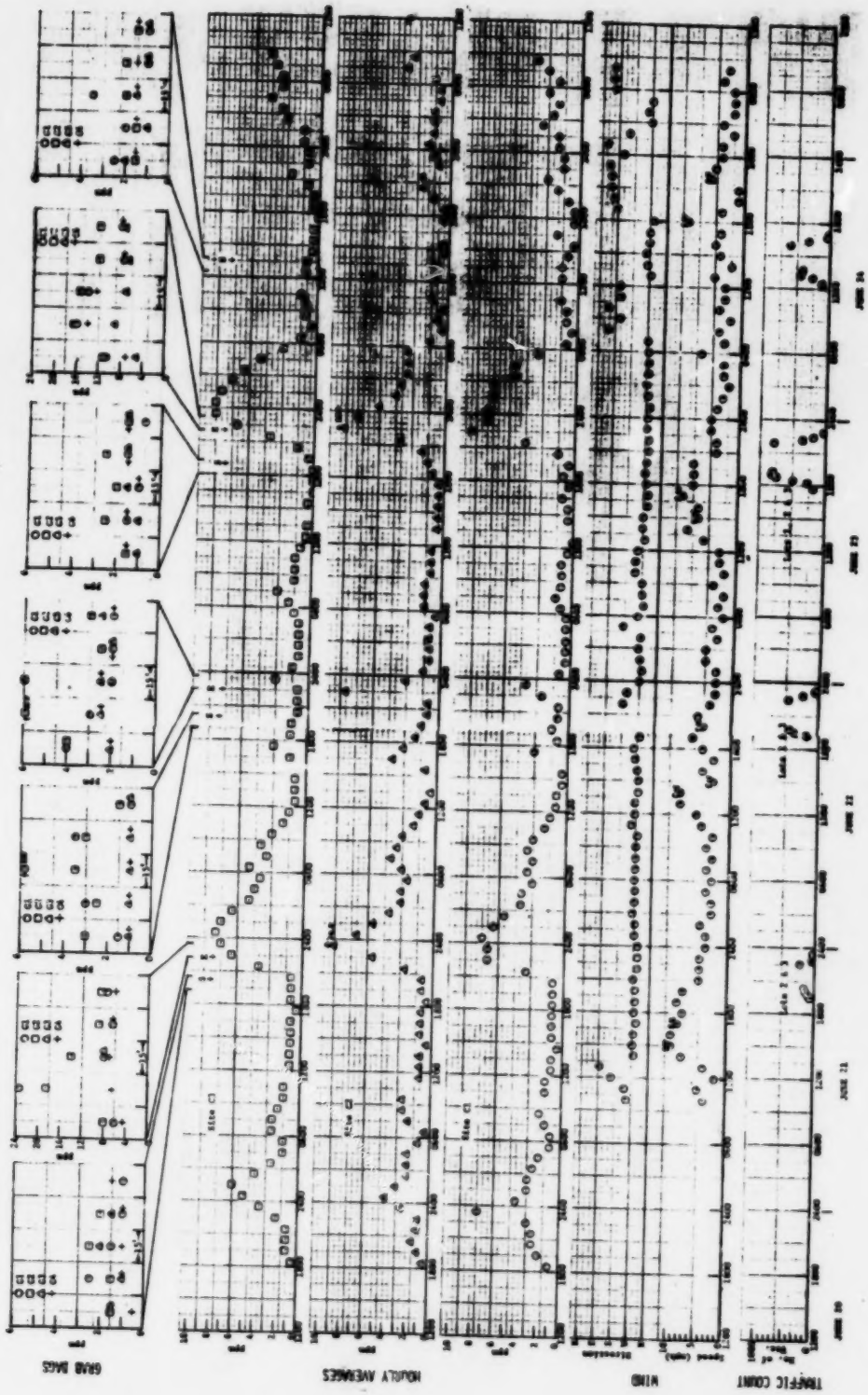

Fig. 8. Reduced Pittsburgh Data

As the valley begins to fill with cooler air, a temperature inversion is gradually established which confines the vertical mixing depth of the air near the valley floor and inhibits further influx of air through drainage. At the same time, the air along the valley floor moves up-river, bringing down-river CO into the stadium area. (The nighttime wind speeds decrease as the down-river drainage reduces the up-river "synoptic" flow.)

The higher concentrations observed about midnight could have been from drainage into the valley three hours previously and 10 to 20 miles down-river. The gradual decrease of CO concentrations toward morning could be the result of the inversion limiting further drainage into the valley floor, industrial plants closing for the night, or some other means of keeping CO out of the valley floor. (Potential industrial sources down river were not investigated.)

The inversion dissipates shortly after sunrise. Since fumigation conditions that occur in similar topography are absent, CO concentrations aloft are similar to those at the valley floor.

Some credence to this hypothesis is given by the presence of nearly clear skies and hence better radiational cooling through most of the night of June 23-24 when the greatest rise in concentration occurred. On other nights when a similar trend occurred, scattered low clouds and at worst, high broken cirrus clouds were observed near sunset, gradually

increasing in amount over the night. On the nights when the trend failed to occur, radiative cooling at sunset was not as intense because of ceilings (more than half or more of the sky covered) at 5,000 feet and 11,000 feet. On the night of June 24-25, thunderstorms, northeasterly winds and heavy ground fog apparently dispersed what appears to be a nocturnal CO increase.

Only the effect of traffic at the end of each game can be detected above the background in the hourly averages (see Figure 8). The increase of the hourly average beginning at the end of the game ranges from zero to 19 ppm for the site most influenced by traffic (C2).

The eight-hour running averages for each of the continuous monitoring stations are shown in Figure 9 and reflect the diurnal trend. The maximum eight-hour average and the maximum one-hour average values for each day are presented in Table V.

TABLE V. MAXIMUM ONE-HOUR AND EIGHT-HOUR AVERAGE CO CONCENTRATIONS OBSERVED IN PITTSBURGH

		Position					
		C1		C2		C3	
Date	Average Period	Conc (ppm)	Period Ending	Conc (ppm)	Period Ending	Conc (ppm)	Period Ending
21 June (Thurs)	1 hr.	7.0	2300&2400	14.0	2400	7.5	2400
	8 hr.	3.5	0400	3.3	2400	3.3	0700
22 June (Fri)	1 hr.	7.5	0100	7.0	0100	8.0	0100
	8 hr.	5.6	0500	5.6	0600	6.2	0600
23 June (Sat)	1 hr.	9.5	2300	25.0	2300	9.0	2400
	8 hr.	3.3	2400	5.3	2400	2.75	2400
24 June (Sun)	1 hr.	8.0	0100	6.0	0100&1700	9.0	0100
	8 hr.	7.0	0500	7.3	0500	7.1	0500
25 June (Mon)	1 hr.	4.0	0900	4.0	0800	4.5	0500&0900
	8 hr.	2.8	0900	1.9	0700	3.5	0900

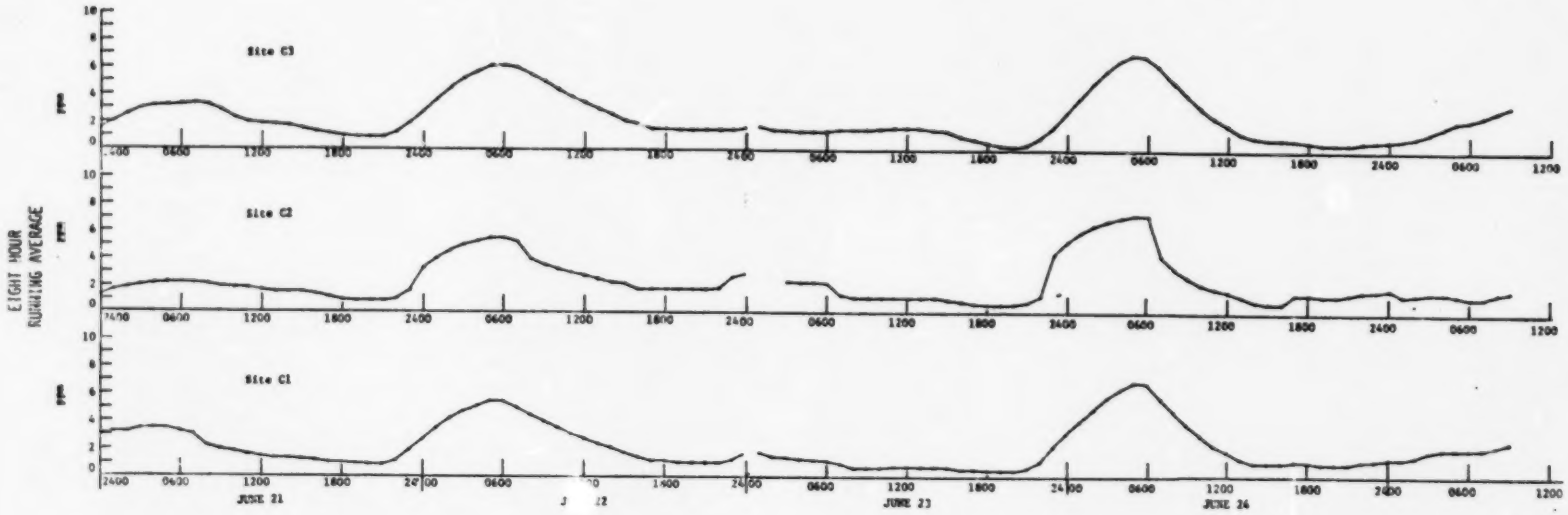

Fig. 9. Eight hour running averages at Pittsburgh. Averages are plotted at the end of the eight hour period of average.

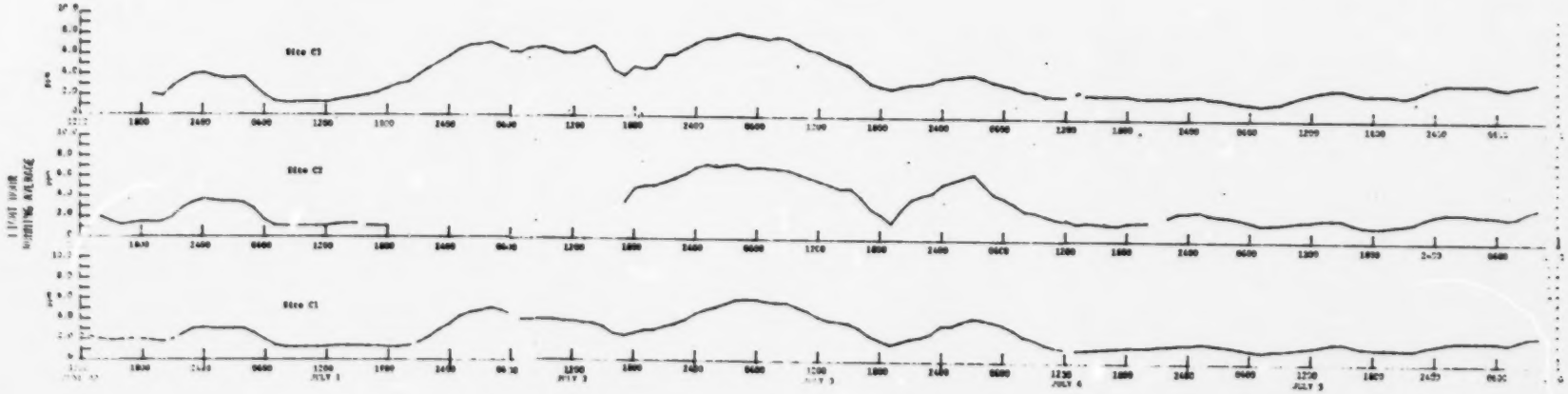

Fig. 12. Eight hour running averages at Atlanta. Averages are plotted at the end of the eight hour period of average.

4.1.2 Stadium Activities

The effect of the prevailing wind and the game-related traffic is obvious. CO concentrations measured at location C3, upwind of the stadium show almost no effect from stadium traffic pre-game or post-game. At the midpoint of the sampling array, C1, pre-game traffic is perceptible but inconsequential. Post-game traffic usually makes a 30 to 45-minute impulse of 5 to 7 ppm amplitude upon the diurnal trend. This impulse is in response to the traffic leaving lots 1, 2, and 3 and moving roughly parallel to the wind direction past the location. Downwind of the stadium parking lots, where the traffic must turn north and slowly pass or idle (because of a traffic light) within 40 feet of location C2, the greatest concentrations of CO are found for 30 to 60 minutes after the end of the game. A theoretical model developed in Appendix E for Site C2 and the CO concentrations predicted by the model were compared to measured concentrations. The concentrations return to background levels soon after the cars have gone. The magnitude of the post-game rise is almost in proportion to the attendance.

An hourly average concentration of 25.0 ppm measured at site C2 on June 23 was the largest observed at any site in Pittsburgh or Atlanta. That concentration is still less than the 35.0 ppm National Air Quality Standard for one hour.

Three of the games were played at night. The lone day game--on Sunday, June 24--shows only a minor change in the post-game concentrations measured at C1 and a moderate (for the location) increase at C2. Better vertical mixing of the air and a lower attendance are probably responsible.

4.1.3 Grab Samples

Pre-game samples were, with one exception, 4.0 ppm or less (see Figure 8), and in agreement with the continuous monitoring results. The two-to-three-hour influx of vehicles, good vertical mixing conditions and the higher wind speeds all contribute to good dispersion of the CO. Samples taken within the stadium were typical of those taken at locations in the parking areas.

Post-game samples were also compatible with the continuous monitoring readings. Usually one sample from G1 and G2 showed a particularly high concentration. G2, because of its downwind location, usually showed higher values than G1 toward the end of the sampling period. Locations G3 and G4 (later G5 and G6, respectively) showed a rise and fall pattern, generally in keeping with the continuous monitoring sites. (The last day's values for these positions are somewhat suspect because of a temporary malfunction of a strip chart recorder and are not shown in Figure 8.) It is somewhat surprising that G5 had low readings since it was only 75 feet from a roadway for exiting cars.

4.1.4 Traffic Count

Transportation to and from the stadium is by means of automobiles, buses and boats. While only a small percentage of the people use boats, a fairly large fraction of the people use the public buses (diesel powered).

Traffic counts, albeit with some inaccuracies, of cars entering or leaving Lots 2 and 3 or 1, 2, and 3, are shown in Figure 8. The maximum rate of incoming cars within the time period of measurements usually

reaches its peak (12 cars per minute) 20 to 40 minutes before the game. After the end of the game, there is about a 5 to 7 minute delay while people get to the cars before everyone tries to get out at the same tiem. The duration of the resulting traffic congestion is dependent upon the closeness of the game in the late innings and the attendance.

Scatter diagrams of the grab sample concentrations at G1 and G2 versus the traffic counts for the same period were plotted and are shown in Figure 10. Visual inspection showed little correlation of the data.

Observations of ingress times for cars showed an average time of two to three minutes to park the car in Lot 2 or 3 after turning from the street. Cars were observed to take somewhat more than one minute and less than 10 minutes to leave the lots and enter the traffic moving away from the stadium at the end of games. The egress time depended mainly on where the car was parked in relation to the lot exit.

About two minutes are required to walk the length of the parking lot. Two to three more minutes are required to enter the stadium gates. Ingress and egress times for cars and people relative to the beginning and ends of games are plotted in Figure 11.

4.1.5 Wind Characteristics

Contrary to expectations, wind speeds measured at Three Rivers Stadium were usually less than those measured at Greater Pittsburgh Airport, although the expected prevailing west winds were fewer. The average speed at the stadium was 5.4 mph and 6.6 mph at the airport, for 95 consecutive hours at each location. Table VI summarizes the wind speed observations by speed categories for the two locations.

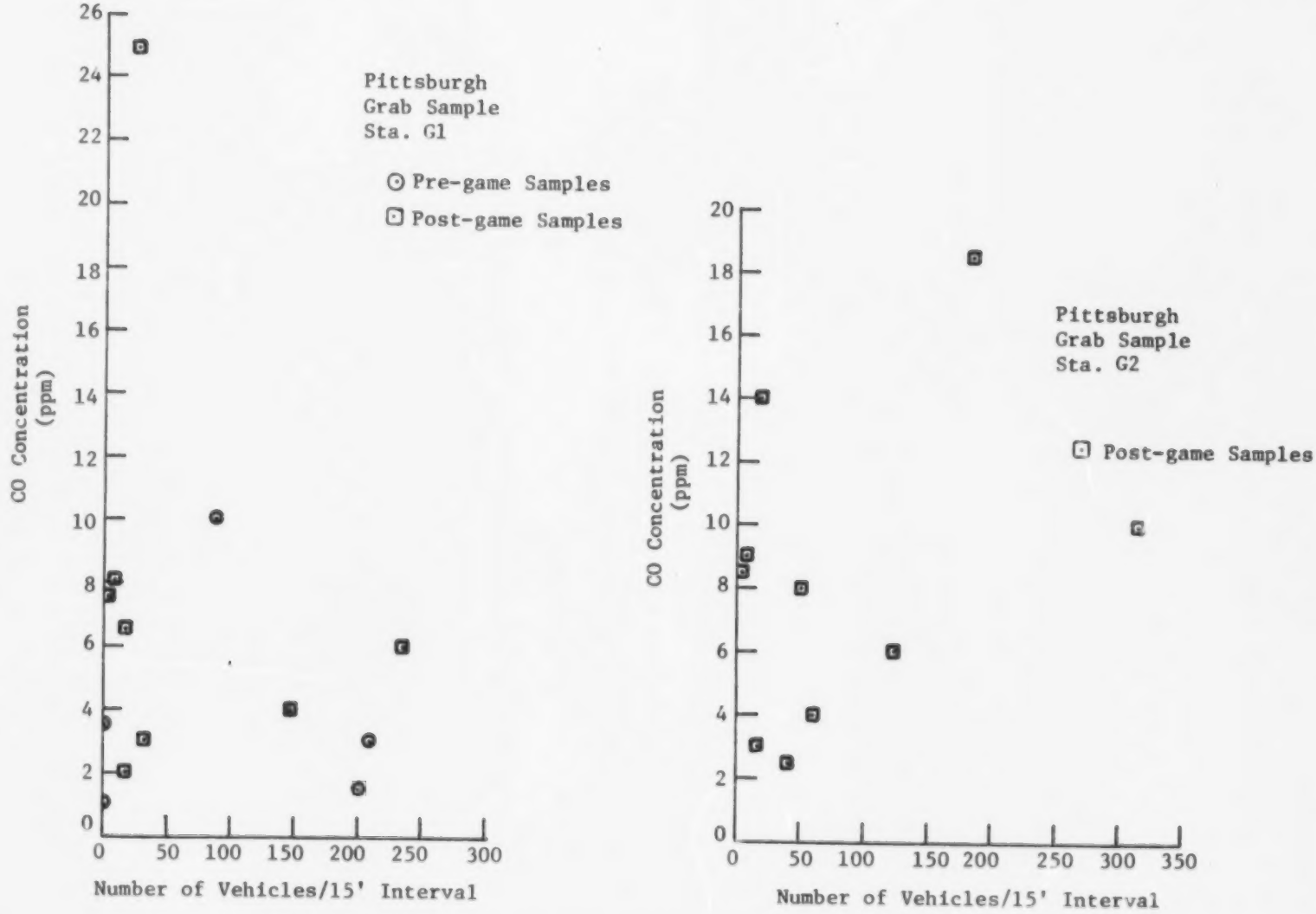

Fig. 10. CO concentration versus traffic count; Pittsburgb.

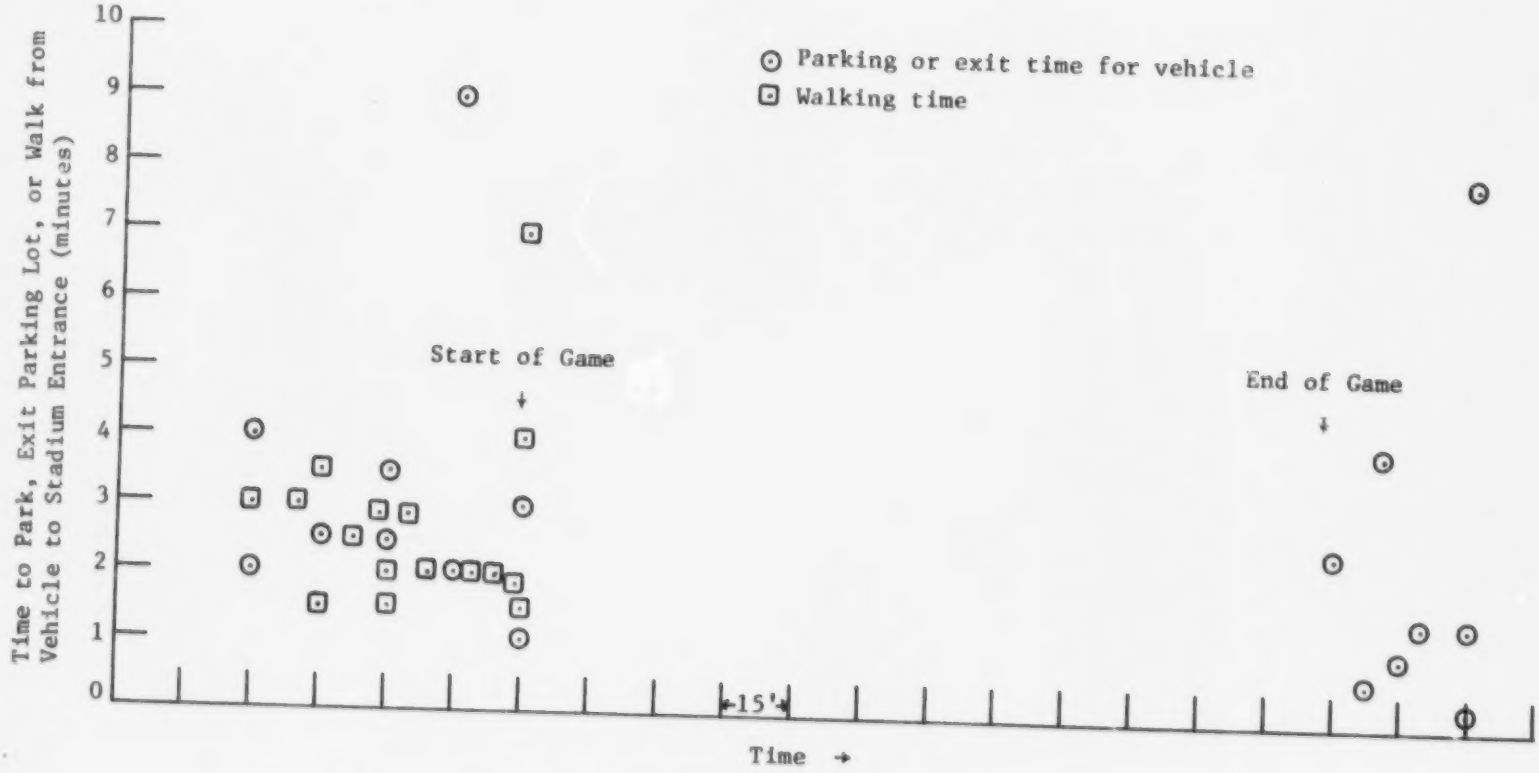

Fig. 11. Representative ingress and egress for cars and people.

Table VI. FREQUENCY OF OCCURRENCE OF WIND SPEED CATEGORIES; PITTSBURGH

Speed (mph)	Stadium	Airport
≤ 3	0.37	0.27
> 3 but ≤ 7	0.47	0.36
> 7 but ≤ 11	0.16	0.33
> 11	0.00	0.04

A study of the "agreement" of the hourly wind speed and direction between the locations showed that in 34 percent of the hours, the wind directions differed by 20 degrees or less and in 49 percent of the hours the wind directions differed by 40 degrees or less; the wind speed differed by 2 mph or less in 60 percent of the hours and by 5 mph or less in 92 percent of the hours. The joint occurrences of these conditions are expressed in Table VII.

Table VII. JOINT PERCENTAGE FREQUENCY OF OCCURRENCE OF WIND SPEED OF DIRECTION CATEGORIES; PITTSBURGH

		Magnitude of Wind Direction Difference	
Magnitude of Wind Speed Difference		≤ 20 deg	≤ 40 deg
	≤ 2 mph	25	34
	≤ 5 mph	30	46

Less than half of the wind speeds and directions were within the upper bounds of the analysis. The principal reason for this result is that the wind directions at the airport showed greater directional variability during the comparison period. Furthermore, given the constraints of the topography and the frequency of winds less than 7 mph at the stadium site, it is not surprising that the valley flow predominated.

The lower wind speeds at the stadium may partially be caused by the nearness of the anemometer to the stadium structure. Without an independent, on-site check, it is impossible to assess the extent of the stadium influence. However, if it is assumed that the air flows around the stadium rather than over and through it, the air should experience an acceleration since the streamlines of the flow are compressed, a higher velocity, especially in a westerly or easterly flow, should result. If it is argued that the anemometer was in a frictional sublayer of the flow about the stadium, then the wind direction should be more variable, responding to eddy motions. The vane strip chart traces do not exhibit great variability except as would be expected in low wind speed conditions.

That the wind speeds measured at the stadium were smaller than the airport speeds, in contradiction to the preconstruction study of DeNardo and McFarland[1], is not completely surprising. The data from the former study was taken atop a 20-foot mast erected on the top of a one-story building before clearing began for the stadium. Hence, elevation and local surface characteristics have substantially changed. From these considerations it is believed that the winds recorded at the central station during the study are representative of the general conditions which would influence CO concentrations in the stadium vicinity.

4.2 Atlanta

4.2.1 Continuous Monitoring

Cursory examinations of the strip chart record (Figure 5) or the hourly average concentration plots (Figure 13) for Atlanta show that the nocturnal peak as seen in Pittsburgh data was not as prominent.

The variety of days of the week, game times, single and double-header games, the July 4th holiday, and variable winds make comparative analysis more difficult.

The strip charts show more isolated spikes and greater short-term fluctuations since these locations are adjacent to more frequently used streets than those in Pittsburgh. Removing the spikes by the hourly averaging process gives a more continuous pattern. At each of the locations, morning rush-hour traffic principally (we assume) from the expressway system north and west of the stadium area can be identified on July 2, 3, 5, and 6, which were normal weekdays. The evening rush-hour traffic is distinct only on July 2, although the winds at the stadium were westerly and northwesterly (i.e. from the expressway) on July 3 and 5. No data of expressway traffic flow are available.

During the nights of July 1-2 and 2-3, CO concentrations remained at higher levels than any of the other nights. Only scattered clouds above 15,000 feet were reported by the airport weather station through most of those nights, with low wind speeds. This suggests that a near surface inversion may have trapped the air near the ground and fostered slow diffusion. Other nights either began with lower clouds and ceilings and/or had slightly stronger winds, thereby inhibiting the formation and maintenance of stabilized conditions.

Pre-game traffic is more apparent than at Pittsburgh in this set of observations, especially at C2 on July 3. More people attended that

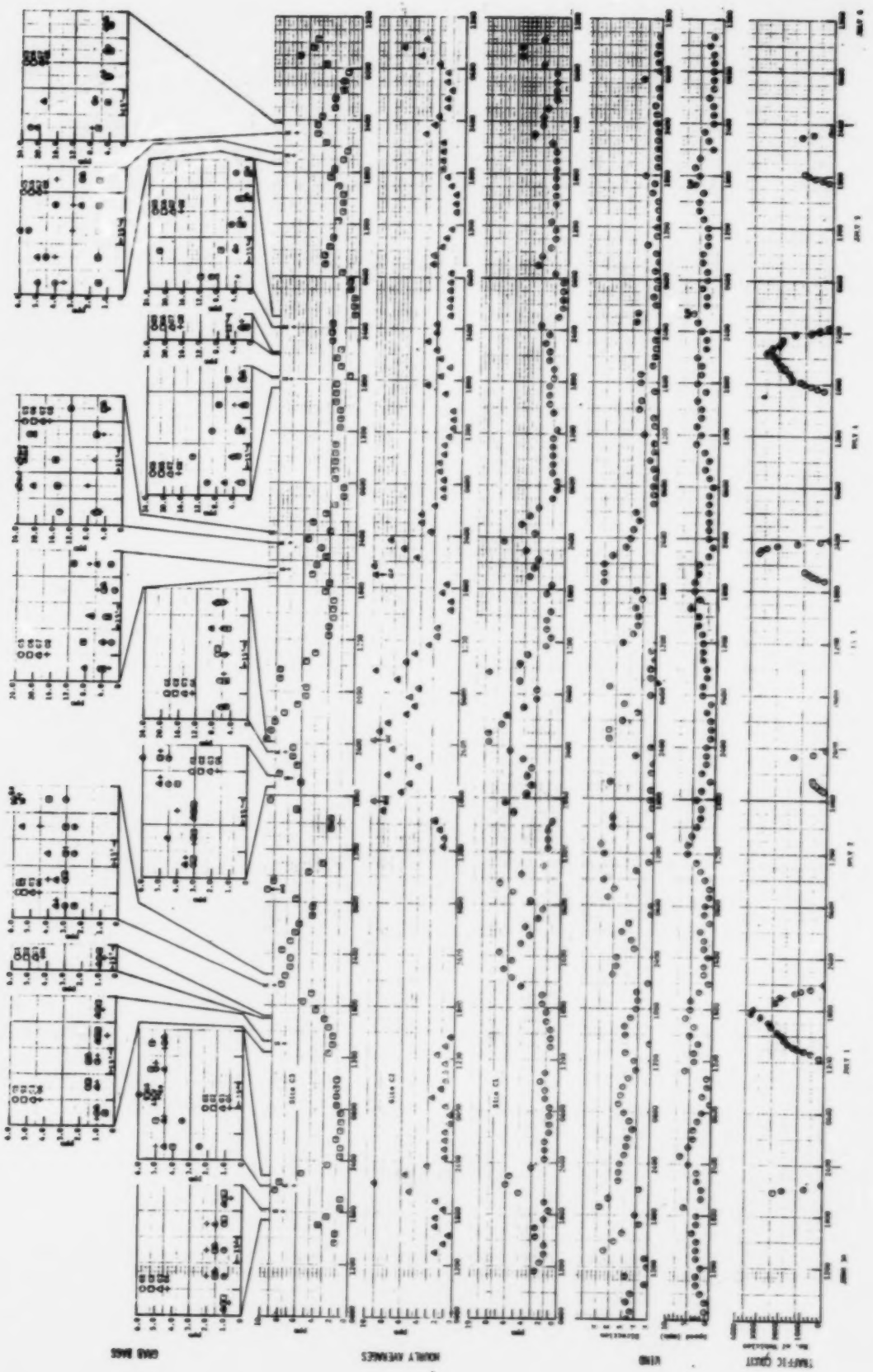

Fig. 13. Reduced Atlanta data.

game so that the parking lot in which C2 was located was used. On most other occasions this lot was not used.

Hourly averages show the nighttime increase and low daytime values, except for the higher values associated with morning expressway traffic, that were noted in Pittsburgh (see Figure 13). The hourly averages corresponding to the end of the games, are from a few tenths to 3 ppm above what appears to be the background trend.

Eight-hour average concentrations shown in Figure 12 (p.30) show that all three of the locations are influenced on this longer term by the same factors. The trends, maxima and minima, all follow the same pattern. The central location, C1, shows concentrations lower by one to two ppm than C2 and C3, which are approximately equal. Maximum one-hour and eight-hour average concentrations for each day are given in Table VIII.

Table VIII. MAXIMUM ONE-HOUR AND EIGHT-HOUR AVERAGE CO CONCENTRATIONS OBSERVED IN ATLANTA

		Position C1		C2		C3	
Date	Average Period	Conc (ppm)	Period Ending	Conc (ppm)	Period Ending	Conc (ppm)	Period Ending
30 June (Sat)	1 hr.	6.0	2200	9.0	2200	8.5	2100
	8 hr.	3.2	2400	3.7	2300	4.1	2400
1 July (Sun)	1 hr.	6.5	2300	2.5	0800	8.5	2100
	8 hr.	3.6	2400	3.4	0100 & 0200	5.8	2400
2 July (Mon)	1 hr.	7.0	0100 & 0900	10.5	0600	10.5	0800
	8 hr.	4.9	0300 & 0500	7.1	2400	7.3	2400
3 July (Tues)	1 hr.	8.5	0100 & 0200 0900	10.5	0100	10.0	0000
	8 hr.	6.1	0500	7.4	0400	8.2	0400
4 July (Wed)	1 hr.	5.0	0200	4.5	0200 & 0300	5.0	0200
	8 hr.	4.3	0300	6.6	0300	4.3	0300
5 July (Thurs)	1 hr.	4.0	2300	4.5	2300	5.0	2300 & 2400
	8 hr.	2.1	1300 & 1400	2.9	0100	3.3	2400
6 July (Fri)	1 hr.	5.5	0800 & 0900	7.0	0900	7.0	0800
	8 hr.	2.9	1000	3.4	1000	3.8	1000

For the first three games, the grab samples were taken in areas adjacent to ticket booths. Pre-game samples were in the range of 1.0 to 3.0 ppm concentration on the first two days, with 3.0 to 6.0 ppm concentrations on July 2. The lower concentrations are perhaps due to the earlier start of the game (1800 and 1330) than on the third day (2000). However, on any given occasion, no significant concentration differences among the locations were found. The between-game samples on July 1 showed no variation with position or time from earlier samples.

Post-game samples on these same days showed more variability in position and in time than the pre-game samples. There is a tendency toward higher concentrations by 1.0 to 3.0 ppm in the third sample. On the whole, these samples were in keeping with the hourly average concentrations measured at C1.

Grab sample sites located beside side streets and auto parking areas during the last three days gave larger and more variable concentrations in the pre-game samples. By being closer to the sources, the concentrations were more dependent upon the local traffic flow and usually exceeded the concentrations at C1. No one station consistently reported concentrations higher than any other. Concentration differences are not consistently wind direction dependent.

Post-game samples on the night of July 3 produced the highest CO concentrations. Six samples, three each from G5 and G7, contained over 20 ppm CO. The maximum value was 50.5 ppm at G7 in the period 45 to 60 minutes after the game and 15 to 30 minutes after a fireworks display. Location G8, upwind of the stadium traffic area and fireworks, recorded a maximum value of 8.0 ppm. By the end of the sampling periods, most

concentrations had decreased to about 4.0 ppm except at G5 where traffic was still heavy. On other nights, G5 and G7 were usually higher than the other locations for the 30 minutes following the game before returning to more uniform conditions.

4.2.3 Traffic Count

The Atlanta traffic counting program was more successful than at Pittsburgh. For the primary entrances/exits, reasonably accurate traffic rates were computed. These are shown in Figure 13. These counts agreed rather well with the total number of cars parked as counted by the Stadium Authority attendants (Table III).

For the Capitol Avenue counters, a plot of total number of vehicles as a function of time was prepared as in Figure 14. To obtain the cars entering the lots the difference of the 15 minute counts at T1 and T2 was used. After the game, the traffic out-flow is taken as the sum of the 15 minute counts at T1 and T2 since cars leaving the northern lots go north and those in the south lots go south, except for those leaving at T3.

On the last three days, G7 was located at T3 and G6 was located at T2. Scatter diagrams of 15 minute grab sample concentrations versus the traffic count for the same period were plotted and are shown in Figure 15. At T3 the pre-game samples and traffic count appeared correlated as the scatter points were clustered together. However, post-game concentrations and vehicle counts were widely scattered. At T2 the same procedure showed scatter about a straight line. Pursuing this further, the linear relation

$$C = -1.21 + 0.5N$$

where C is the concentration in ppm and N is number of vehicles, was

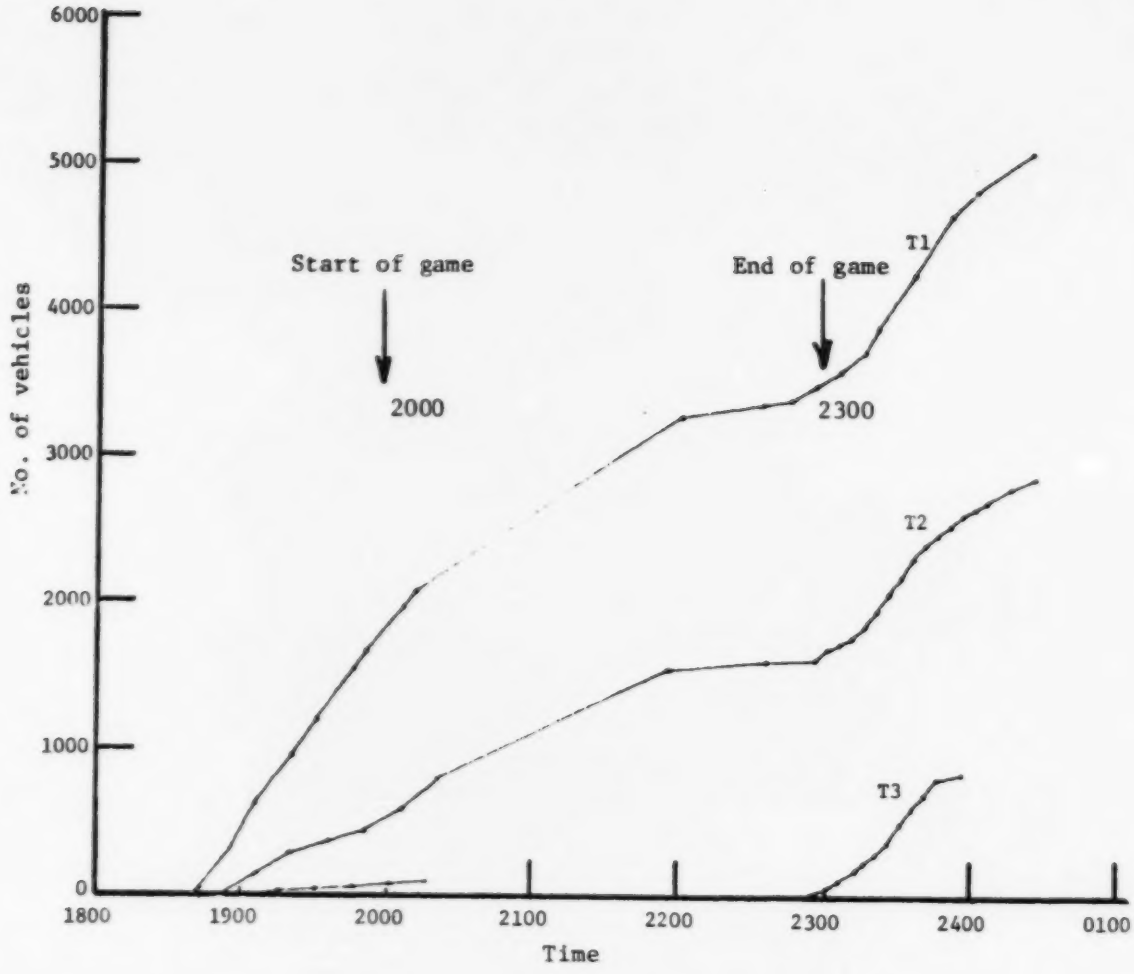

Fig. 14. Traffic count data from sites T1, T2, and T3, 3 July, Atlanta Stadium.

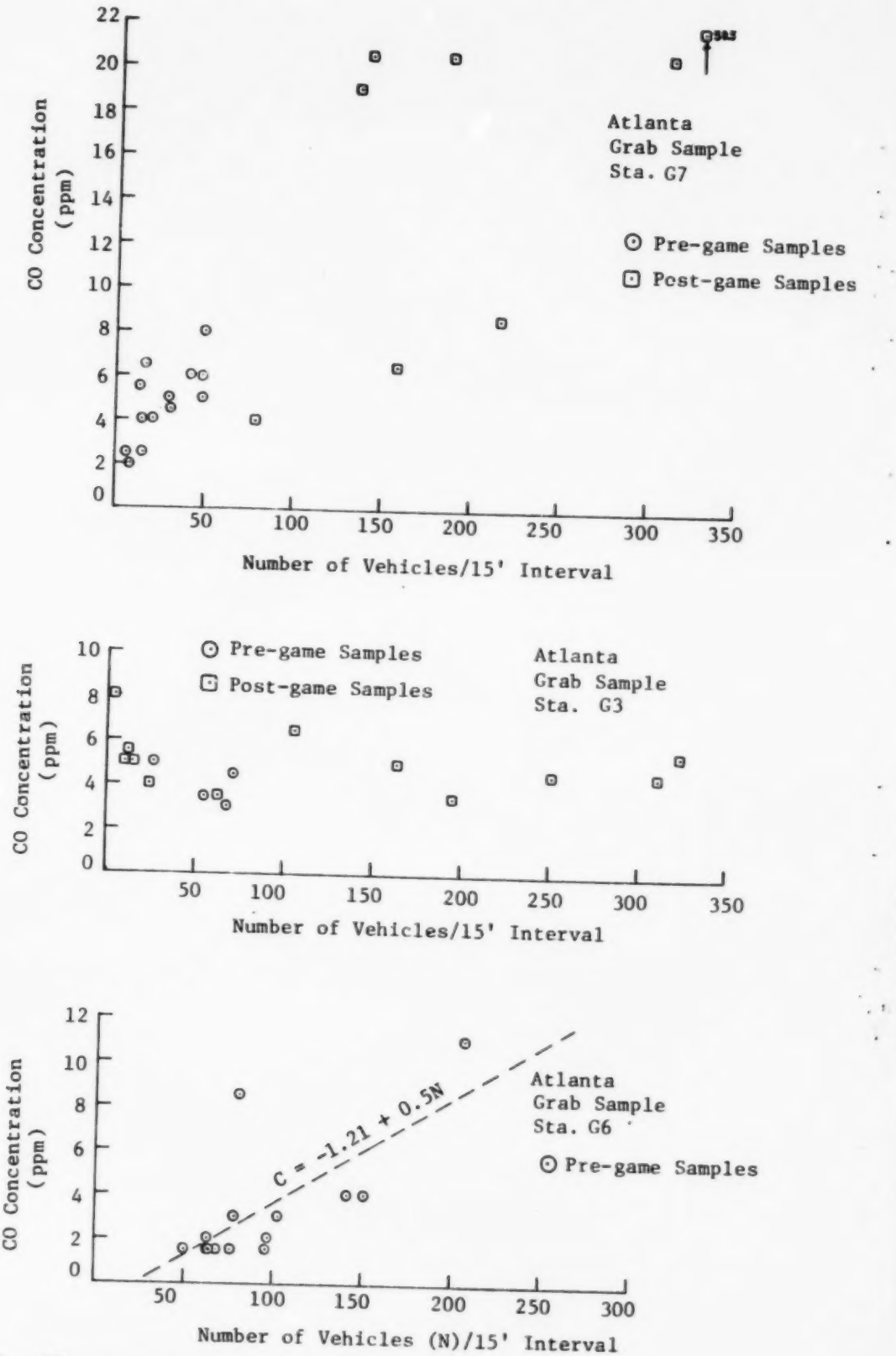

Fig. 15. CO concentration versus traffic count; Atlanta.

found to give the least square linear fit to the data with a correlation coefficient of 0.90.

One to two minutes after a car entered a parking lot it was parked. The time required for people to get from the car to the stadium was, of course, distance dependent. It took 4 to 6 minutes for people to get from the lots south of Georgia Avenue to the stadium. The stadium was within 3 minutes walking time from most portions of the stadium parking lots. If the patron did not have a ticket, an additional five to ten minutes was required to purchase a ticket, regardless of the time before or after the game had begun. No specific observations of egress times were made. Traffic began to jam up at the exits about 10 minutes after the game ended. All lots were practically empty about 30 minutes after the end of a game.

4.2.4 Wind Characteristics

Light and variable winds, mostly from the northwest through north, were characteristic of the seven days of observation in Atlanta. Analyses of the wind-direction strip charts was complicated since North was the ambiguous point; i.e., zero and full-scale deflections on the charts.

Partially because of the light and variable characteristics, winds measured at the stadium had little resemblence to those measured during a 144-hour period at the airport, 10 miles south. Speeds averaged only 3.3 mph at the stadium whereas the airport speeds averaged 6.5 mph. Table IX below gives a breakdown of wind speed occurrences at the two locations.

Table IX. FREQUENCY OF OCCURRENCE OF WIND SPEED CATEGORIES; ATLANTA

Speed (mph)	Stadium	Airport
≤ 3	0.61	0.13
> 3 but ≤ 7	0.38	0.67
> 7 but ≤ 11	0.01	0.19
> 11	0.00	0.01

In only three instances did the stadium wind speed exceed the airport wind speed.

Further analysis of the compatibility of the wind measurements shows that the wind directions differed by 20 degrees or less in 40 percent; and by 40 degrees or less in 57 percent of the comparable hours. Wind speeds were within 5 mph of each other in 95 percent of the reports. However, close agreement in speed and direction was rather infrequent (20 percent) as shown in Table X.

Table X. JOINT PERCENTAGE FREQUENCY OF OCCURRENCE OF WIND SPEED AND DIRECTION CATEGORIES; ATLANTA

		Magnitude of Wind Direction Difference	
		≤ 20 deg	≤ 40 deg
Magnitude of Wind Speed Difference	≤ 2 mph	20	29
	≤ 5 mph	36	52

The reasons for the wind speed differences are not apparent in the topography or exposure of the anemometer in the Atlanta Stadium complex.

5.0 CONCLUSIONS

The primary objectives of the study were accomplished. The main conclusions drawn from the study are:

1) National Ambient Air Quality Standards were not exceeded for either the eight-hour or the one-hour averaging periods.
2) Post-game traffic strongly affects the ambient CO concentrations in the stadium vicinity for an interval of one hour or less in an amount dependent upon the number of vehicles.
3) Pre-game traffic exhibits little influence on ambient CO concentration since cars arrive over a period of several hours.
4) Grab samples may identify occasional "hot spots" but these peak concentrations diminish rapidly. Overall, the grab samples do not add significant information to what can be learned from the continuous monitoring.
5) The combination of meteorological parameters and the topography of the stadium complex area exert the major influence upon the distribution of CO about the complex.
6) Even in conditions of light winds, locally generated CO is rapidly dispersed through horizontal and vertical mixing.
7) Traffic rate and CO concentration at a given location are not necessarily linearly correlated.

6.0 REFERENCES

1. DeNardo and McFarland Weather Services, Wind Study and Analysis for the North Side Stadium, Pittsburgh, October 1965.

2. Climatic Atlas of the United States, U.S. Department of Commerce, Environmental Science Services Administration, Environmental Data Service, June 1968.

3. Compilation of Air Pollutant Emission Factors, U. S. EPA, Office of Air Programs, Publication No. AP-42, February 1972.

APPENDIX A

SAROAD FORMS

Less than 24-hour sampling interval ☐

Agency

I. TERRY T., PENNSYLVANIA
City Name

STELTON SOUTH V.N CI
Site Address

Project

ENVIRONMENTAL PROTECTION AGENCY
National Aerometric Data Bank
Research Triangle Park, N. C. 27711

SAROAD Hourly Data Form

CARBON MONOXIDE
Parameter observed

ONE HOUR
Time interval of obs.

NDIR
Method

PARTS PER HUNDRED MILLION
Units of obs.

State | Area | Site | Agency | Project | Time | Year | Month | Parameter code | Method | Units | DP

Day	St	Hr	Rdg 1	Rdg 2	Rdg 3	Rdg 4	Rdg 5	Rdg 6	Rdg 7	Rdg 8	Rdg 9	Rdg 10	Rdg 11	Rdg 12
20	01	12							100	200	250	350	300	750
21	01	12	400	300	300	250	200	100	100	150	200	---	150	150
	12	24	100	100	050	100	100	100	100	100	100	350	700	700
22	01	12	750	450	550	400	400	300	350	300	350	300	200	150
	12	24	100	100	050	050	---	300	100	150	100	100	250	400
23	01	12	100	350	550	550	250	550	150	150	100	100	150	150
	12	24	000	---	550	550	100	550	100	350	150	450	450	850
24	01	12	400	750	750	550	550	350	100	350	100	100	150	150
	12	24	150	150	100	350	220	350	050	100	200	450	150	150
25	01	12	200	200	300	200	---	300	200	300	400			

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A-3

OMB No. 158-R0012
Approval Expires 6/30/76

...ss than 24-hour sampling interval

1

Agency: PITTSBURGH PENNSYLVANIA

City Name

Site Address: STADIUM TRAILER EAST C2 (#2)

Project

ENVIRONMENTAL PROTECTION AGENCY
National Aerometric Data Bank
Research Triangle Park, N. C. 27711

SAROAD Hourly Data Form

Parameter observed: CARBON MONOXIDE

Time interval of obs.: 1 HOUR

Method: NDIR

Units of obs.: PARTS PER MILLION (HUNDRED)

State | Area | Site

Agency | Project | Time | Year | Month

Parameter code | Method | Units | DP

Day	St	Hr	Rdg 1	Rdg 2	Rdg 3	Rdg 4	Rdg 5	Rdg 6	Rdg 7	Rdg 8	Rdg 9	Rdg 10	Rdg 11	Rdg 12
20	00								050	100	150	100	100	250
	12													
21	00		400	300	200	200	200	100	050	300	250	250	— —	100
	12		100	100	050	100	100	100	050	100	100	250	550	1400
22	00		700	550	400	300	300	250	300	400	350	300	200	150
	12		100	050	— —	100	400	300	200	150	100	100	850	300
23	00		150	100	100	100	100	050	150	150	150	100	100	100
	12		— —	050	050	050	050	050	100	150	200	400	250	800
24	00		600	450	400	350	350	350	150	050	100	050	150	—
	12		100	100	050	050	600	050	300	150	250	250	100	150
25	00		200	150	150	150	100	100	150	400	350			

OMB No. 158-R0012
Approval Expires 6/30/76

Less than 24-hour sampling interval

[1]

Agency

PITTSBURGH PENNSYLVANIA

City Name

STADIUM TRAILER WEST C3

Site Address

Project

ENVIRONMENTAL PROTECTION AGENCY
National Aerometric Data Bank
Research Triangle Park, N. C. 27711

SAROAD Hourly Data Form

CARBON MONOXIDE

Parameter observed

ONE HOUR

Time interval of obs.

NDIR

Method

PARTS PER HUNDRED MILLION

Units of obs.

State | Area | Site (2–10)

Agency (11) | Project (12–13) | Time (14) | Year (15–16) | Month (17–18)

Parameter code (23–27) | Method (28–29) | Units (30–31) | DP (32)

Day (19–20)	St (21–22)	Hr	Rdg 1 (33–36)	Rdg 2 (37–40)	Rdg 3 (41–44)	Rdg 4 (45–48)	Rdg 5 (49–52)	Rdg 6 (53–56)	Rdg 7 (57–60)	Rdg 8 (61–64)	Rdg 9 (65–68)	Rdg 10 (69–72)	Rdg 11 (73–76)	Rdg 12 (77–80)
20	00								50	100	100	100	200	350
	12		—	—	—	—	—	—						
21	00		500	600	400	250	150	150	250	250	200	150	150	—
	12		100	100	100	100		50	100	100	100	400	650	750
22	00		800	750	650	500	450	400	500	350	400	300	200	150
	12		100	100	100	—	150	300	150	150	100	100	100	300
23	00		150	100	100	100	100	150	200	300	150	150	150	100
	12		50	50	—	50	00	00	00	50	150	400	200	900
24	00		900	850	750	650	500	300	150	50	100	100	150	—
	12		100	100	50	50	50	00	50	50	100	250	100	100
25	00		150	150	300	350	450	350	350	400	450			

OMB No. 158-R0012
Approval Expires 6/30/76

A-5

Less than 24-hour sampling interval

[1]

ENVIRONMENTAL PROTECTION AGENCY
National Aerometric Data Bank
Research Triangle Park, N. C. 27711

SAROAD Hourly Data Form

Agency: ATLANTA GEORGIA

City Name: STADIUM EAST (DODGE VAN)

Site Address: C1

Project

Parameter observed: CARBON MONOXIDE

Time interval of obs.: ONE HOUR AVE

Method: NDIR

Units of obs.: PARTS PER HUNDRED MILLION

State | Area | Site | Agency | Project | Time | Year | Month | Parameter code | Method | Units | DP

Day	St	Hr	Rdg 1	Rdg 2	Rdg 3	Rdg 4	Rdg 5	Rdg 6	Rdg 7	Rdg 8	Rdg 9	Rdg 10	Rdg 11	Rdg 12
30	00													
	12		200	150	150	250	250	150	120	150	450	600	550	350
01	00		150	150	150	100	100	100	100	150	150	200	150	300
	12		---	100	100	100	150	150	200	200	450	550	650	550
02	00		700	450	350	400	250	100	350	550	700	450	200	---
	12		150	150	150	100	250	650	400	350	400	350	450	400
03	00		850	850	700	650	450	300	300	600	850	500	400	200
	12		150	200	200	150	---	200	150	400	350	300	450	700
04	00		250	500	400	300	150	100	100	150	150	120	150	150
	12		100	---	150	200	200	200	150	150	200	200	250	200
05	00		300	100	050	050	050	050	150	350	300	200	150	150
	12		200	---	150	150	150	150	150	150	150	200	400	300
06	00		300	200	150	---	---	---	300	550	550	300	---	---
	12		---	---	---	---	---	---	---	---	---	---	---	---

OMB No. 158-R0012
Approval Expires 6/30/76

4-9

Less than 24-hour sampling interval

[1]

Agency

ATLANTA GEORGIA

City Name

NORTHEAST TRAILER (FULTON & FRASIER) C2

Site Address

Project

ENVIRONMENTAL PROTECTION AGENCY
National Aerometric Data Bank
Research Triangle Park, N. C. 27711

SAROAD Hourly Data Form

CARBON MONOXIDE

Parameter observed

1 HR AVE

Time interval of obs.

NDIR

Method

PARTS PER HUNDRED MILLION

Units of obs.

State | Area | Site

Agency | Project | Time | Year | Month

Parameter code | Method | Units | DP

Day	St	Hr	Rdg 1	Rdg 2	Rdg 3	Rdg 4	Rdg 5	Rdg 6	Rdg 7	Rdg 8	Rdg 9	Rdg 10	Rdg 11	Rdg 12
30	00			200	100	50	200	200	100	200	500	900	550	300
30	12													
01	00		100	100	100	100	50	50	100	250	150	100	100	100
01	12		200	100	50									
02	00													
02	12			150	200	250	250	250	650	550	800	450	550	750
03	00	1	950	900	800	600	500	550	450	700	950	700	500	350
03	12		250	250	- - -	100	100	200	150	1100	1000	500	650	800
04	00		350	450	450	300	200	200	200	250	250	200	200	150
	12		100	100	100	- - -	200	400	250	150	250	300	400	300
05	00		300	150	100	100	100	100	150	350	350	250	200	150
	12		- - -	100	100	100	150	200	250	250	250	250	450	350
06	00		300	200	200	150	200	200	300	500	200	450		

OMB No. 158-R0012
Approval Expires 6/30/76

A-7

Less than 24-hour sampling interval

[1]

Agency: ATLANTA, GEORGIA

City Name: TRAILER SOUTHWEST C3

Site Address

Project

ENVIRONMENTAL PROTECTION AGENCY
National Aerometric Data Bank
Research Triangle Park, N. C. 27711

SAROAD Hourly Data Form

CARBON MONOXIDE — Parameter observed

HOURLY AVERAGES — Time interval of obs.

NDIR — Method

PARTS PER HUNDRED Million — Units of obs.

State | Area | Site

Agency | Project | Time | Year: 73 | Month: 06

Parameter code: 42101 | Method: 11 | Units: - - | DP: 2

Day	St	Hr	Rdg 1	Rdg 2	Rdg 3	Rdg 4	Rdg 5	Rdg 6	Rdg 7	Rdg 8	Rdg 9	Rdg 10	Rdg 11	Rdg 12
30	00				150	150	250	250	100	100	850	800	550	250
	01													
	02													
01	00		100	100	150	100	100	100	150	150	150	150	---	---
	01		250	200	200	250	300	400	550	450	800	750	700	700
	02													
02	00		800	700	650	600	450	450	650	1050	900	500	350	
	01		---	---	250	250	650	950	700	600	850	650	700	700
	02													
03	00	1	000	950	900	800	650	550	350	850	850	550	450	---
	01		300	300	250	250	250	350	300	300	450	350	400	550
	02													
04	00		300	500	350	250	150	150	250	250	250	250	250	---
	01		200	200	200	250	250	250	100	200	250	200	300	300
	02													
05	00		300	050	050	050	100	100	200	400	400	350	300	---
	01		250	200	200	200	250	350	300	200	150	400	500	500
	02													
06	00		450	350	300	200	200	150	400	700	550	500		

OMB No. 158-R0012
Approval Expires 6/30/76

Instructions
- Make Count
- Check flow
- Run at "3" for 4 min
- Observe reading for 1 min
- Record Average

GRAB SAMPLE ANALYSIS

DATE 6-21-73 STATION NO. G1-4

21'73 LOCATION PITTSBURGH ANALYSIS METHOD MSA-NDIR

'00 PERSON PERFORMING ANALYSIS Phil Rasberry

Adjusted to +1.0 mv on Zero Gas and 50 mv on Span Gas

SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	CO CONCENTRATION (ppm)	
G-2-1	1915			4.2 mv	1.5
G-2-2	1930	1945		4.3 mv	1.5
G2-3	194_			6.2 mv	2.5
G2-4	20_0			5.1 mv	2.0
G3-1	1915			3.7 mv	1.5
G3-2	1930			2.5 mv	1.0
G3-3	1945			4.7 mv	2.0
G3-4	2000			3.7 mv	1.5
G1-1		MISSED	VALVE PROBLEM		-
G1-2	1932			5.7 mv	2.5
G1-3	1948			3.7 mv	1.5
G1-4	2003			3.1 mv	1.0
G1-5	2019			3.2 mv	1.0
G4-1	19:15			2.2 mv	0.5
G4-2	19:30			2.9 mv	1.0
G4-3	19:45			2.8 mv	1.0
G4-4	20:00			2.9 mv	1.0
G4-5	20:15			3.5 mv	1.5

START OF GAME

Pages B-1 and B-2 are blank.

GRAB SAMPLE ANALYSIS

DATE 6-21-73 STATION NO. 61-4

LOCATION PITTSBURGH ANALYSIS METHOD MSA-NDIR

PERSON PERFORMING ANALYSIS Phil Rarbary

1/73 End of Game Attendance 10,099

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G3-6	23:01			23:55	17.3 MV	1.0	16.3	8.0 Δ
Check valve problems			No more	G-3 samples				
				6/24/73				
G1-6	22:30			00:33	13.0	1.0	12.0	6.0
G1-7	22:45			00:26	48.0	1.0	47.0	23.5
G1-8	23:00			00:04	16.6	1.3	15.3	8.0 ○
G1-9	23:15			00:19	14.5	1.3	13.2	6.5
G1-10	23:30			00:13	15.8	1.3	14.5	7.5
G2-5	22:32			01:08	16.9	1.3	15.6	8.0
G2-6	22:47			00:48	38.5	1.3	37.2	18.5
G2-7	23:03			00:54	29.3	1.3	28.0	14.0 □
G2-8	23:19			01:01	19.0	1.3	17.7	9.0
G2-9	23:35			00:42	18.6	1.3	17.3	8.5
G4-6	22:43			01:41	10.0	1.3	8.7	4.5
G4-7	22:58			01:20	14.0	1.3	12.7	6.5
G4-8	23:13			01:33	15.6	1.3	14.3	7.0 +
G4-9	23:28			01:26	14.2	1.3	12.9	6.5
G4-10	23:43			01:13	13.1	1.3	11.8	6.0
Calibration 6/22/73 02:00				Phil				
Unadjusted Zero = 1.3 mv								
Unadjusted Span = 50.1 mv								

END OF GAME

GRAB SAMPLE ANALYSIS

DATE 6/22/73 STATION NO. G1-4

LOCATION Pittsburgh ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rabney ADJUST CALIBRATION 19:15

Zero Gas = 1.0

Span Gas = 50.3

FORE GAME SAMPLES

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G4-1	19:03			20:49	2.8mv		1.8	1.0
G4-2	19:19			20:37	2.8mv		1.8	1.0 +
G4-3	19:35			20:41	3.4mv		2.4	1.0
G4-4	19:51			20:31	3.1mv		2.1	1.0
G4-5	- Not	Taken	- displaced from station					
G3-1	19:00			21:23	3.3mv		2.3	1.0
G3-2	19:15			21:11	3.2mv		2.2	1.0
G3-3	19:30			21:05	3.8mv		2.8	1.0 Δ
G3-4	19:45			21:18	3.7mv		2.7	1.0
G3-5	20:01			20:58	3.6mv		2.6	1.0
G2-1	19:00			21:50	7.4mv		6.4	3.0
G2-2	19:15			21:45	6.0mv		5.0	2.5
G2-3	19:30			21:40	8.0mv		7.0	3.5 D
G2-4	19:45			21:35	6.7mv		5.7	3.0
G2-5	20:00			21:30	3.8mv		2.8	1.5
G1-1	19:00			22:15	3.6mv		2.6	1.5
G1-2	19:15			22:00	7.4mv		6.4	3.0
G1-3	19:30			22:11	21.1mv		20.1	10.0 ✓
G1-4	19:45			21:55	7.5mv		6.5	3.5
G1-5	20:00			22:06	2.6mv		1.6	1.0

GRAB SAMPLE ANALYSIS

DATE 6/22/73 STATION NO. G1, G2, G5, & G6

LOCATION Pittsburgh ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Paul Rasmussen UNADJUSTED CALIBRATION ZERO 1.5 mV SPAN 50.8 mV

TER GAME SAMPLES ATTENDANCE 21,129

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G1-6	22:35			23.35	9.6 mV	1.5	8.1	4.0
G1-7	22:50			23:28	8.3 mV	1.5	6.8	3.0
G1-8	23:05			00:59	5.7 mV	1.5	4.2	2.0
G1-9	23:20			01:05	5.9 mV	1.5	4.4	2.0
G1-10	23:35			00:55	5.7 mV	1.5	4.2	2.0
G2-6	22:30			00:27	9.3 mV	1.5	7.8	4.0
7	22:45			00:12	21.7 mV	1.5	20.2	10.0
8	23:00			00:22	13.0 mV	1.5	11.5	6.0
9	23:15			00:17	6.9 mV	1.5	5.4	2.5
10	23:30			00:06	7.2 mV	1.5	6.7	3.0
G6-6	22:35			00:01	5.5 mV	1.5	4.0	2.0
7	22:50			23:52	6.6 mV	1.5	5.1	2.5
8	23:05			23:56	5.9 mV	1.5	4.9	2.5
9	11:20			00:50	5.5 mV	1.5	4.0	2.0
10	23:35			00:45	5.9 mV	1.5	4.4	2.0
G5-6	22:30			00:41	5.4 mV	1.5	3.9	2.0
7	22:45			23:46	6.7 mV	1.5	5.2	2.5
8	23:00			23:40	6.9 mV	1.5	5.4	2.5
9	23:18			00:37	6.1 mV	1.5	4.6	2.0
10	23:33			00:32	6.3 mV	1.5	4.8	2.5

GRAB SAMPLE ANALYSIS

DATE JUNE 23 STATION NO. G1, G2, G5, & G6

LOCATION PITTSBURGH ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Raisberry

PRE GAME WDB

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G-1-1	1800	1815		1948	2.7	1.0	1.7	1.0
G-1-2	1815	1830		1940	4.3	1.0	3.3	1.5
G-1-3	1830	1845		1944	3.5	1.0	2.5	1.0
G-1-4	1845	1900		1935	4.0	1.0	3.0	1.5
G-1-5	1900	1915		1930	3.3	1.0	2.3	1.0
G-2-1	1800	1815		2015	4.0	1.0	3.0	1.5
G-2-2	1815	1830		2010	5.9	1.0	4.9	2.5
G-2-3	1830	1845		2006	5.0	1.0	4.0	2.0
G-2-4	1845	1900		2001	6.3	1.0	5.3	2.5
G-2-5	1900	1915		1955	4.0	1.0	3.0	1.5
G-5-1	1805	1822		2100	3.0	1.0	2.0	1.0
G-5-2	1822	1837		2054	3.3	1.0	2.3	1.0
G-5-3	1837	1852		2050	3.7	1.0	2.7	1.5
G-5-4	1852	1908		2045	4.3	1.0	3.3	1.5
G-5-5	1908	1923		2039	3.6	1.0	2.6	1.5
G-6-1	1800	1815		2036	4.0	1.0	3.0	1.5
G-6-2	1815	1830		2027	4.0	1.0	3.0	1.5
G-6-3	1830	1845		2031	3.3	1.0	2.3	1.0
G-6-4	1845	1900		2024	4.3	1.0	3.3	1.5
G-6-5	1900	1915		2020	3.7	1.0	2.7	1.5

GRAB SAMPLE ANALYSIS

DATE 6/23/73 STATION NO. G1, G2, G5, & G6

LOCATION Pittsburgh ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasberry

POST-GAME SAMPLES

ATTENDANCE 24,359

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G1-6	21:56	22:11		23:12	21.3	1.0	21.3	10.5
7	22:11	22:26		23:22	33.0	1.0	32.0	16.0
8	22:26	22:40		23:16	29.9	1.0	28.9	14.0
9	22:41	22:56		23:42	16.0	1.0	15.0	7.5
10	22:56	~~23:11~~		23:48	16.9	1.0	15.9	8.0
G2-6	21:55	22:10		00:20	23.1	1.0	22.1	11.0
7	22:10	22:25		00:24	33.9	1.0	32.9	16.5
8	22:25	22:40		00:30	31.7	1.0	30.7	15.5
9	22:40	22:55		00:17	24.6	1.0	23.6	12.0
10	22:55	23:10		00:13	25.3	1.0	24.3	12.0
G5-6	21:58	22:14		23:56	11.7	1.0	10.7	5.0
7	22:14	22:29		24:00	18.5	1.0	17.5	9.0
8	22:29	22:45		00:08	15.5	1.0	14.5	7.0
9	22:45	23:00		00:04	14.4	1.0	13.4	6.5
10	23:00	23:15		23:52	16.2	1.0	15.2	7.5
G6-6	21:55	22:10		23:35	15.3	1.0	14.3	7.0
7	22:10	22:25		23:00	28.7	1.0	27.7	14.0
8	22:25	22:40		23:05	26.3	1.0	25.3	12.5
9	22:40	22:55		23:30	16.3	1.0	15.3	7.5
10	22:55	23:10		23:28	16.9	1.0	15.9	8.0

GRAB SAMPLE ANALYSIS

DATE 6/24/73 DAY GAME STATION NO. 61, 62, 65, & 66

LOCATION Pittsburgh ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasberry

PRE GAME SAMPLES

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G1- 1	12:30	12:45		15:10	6.2	1.0	5.2	2.5
2	12:45	13:00		15:01	5.3	1.0	4.3	2.0
3	13:00	13:15		15:06	8.2	1.0	7.2	3.5
4	13:15	13:30		14:57	3.0	1.0	2.0	1.0
5	13:30	13:45		14:52	3.0	1.0	2.0	1.0
G2- 1	12:30	12:45		14:45	4.4	1.0	3.4	1.5
2	12:45	13:00		14:40	4.0	1.0	3.0	1.5
3	13:00	13:15		14:35	4.6	1.0	3.6	2.0
4	13:15	13:30		14:31	4.7	1.0	3.7	2.0
5	13:30	13:45		14:26	3.6	1.0	2.6	1.5
G5- 1	12:30	12:46		14:22	4.7	1.0	3.7	2.0
2	12:46	13:01		14:18	3.5	1.0	2.5	1.0
3	13:01	13:16		14:14	3.8	1.0	2.8	1.5
4	13:16	13:31		14:09	3.1	1.0	2.1	1.0
5	13:31	13:46		14:03	2.8	1.0	1.8	1.0
G6- 1	12:30	12:45		15:37	4.2	1.0	3.2	1.5
2	12:45	12:30		15:17	4.4	1.0	3.4	1.5
3	12:59	13:15		15:32	3.6	1.0	2.6	1.5
4	13:15	13:30		15:27	3.8	1.0	2.8	1.5
5	13:30	13:45		15:23	4.1	1.0	3.1	1.5

CRAB SAMPLE ANALYSIS

DATE 6/24/73 STATION NO. 61, 62, 65, & 66

LOCATION Pittsburgh ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasberry

POST GAME SAMPLES ATTENDANCE 20,000+

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G1-6	16 12	1627		1720	6.3	1.0	5.3	2.5
7	1627	1642		1730	6.6	1.0	5.6	3.0
8	1642	1657		1736	6.0	1.0	5.0	2.5
9	1657	1712		1742	6.0	1.0	5.0	2.5
10	1712	1727		1746	6.1	1.0	5.1	2.5
G2-6	16:10	16:25		18:14	10.1	1.0	9.1	4.5
7	16:25	1640		18:03	11.0	1.0	10.0	5.0
8	16:40	16:55		18:09	10.6	1.0	9.6	5.0
9	16:55	17:10		17:58	6.2	1.0	5.2	2.5
10	17:10	17:25		17:53	6.2	1.0	5.2	2.5
G5-6	16:20	16:35		18:40	9.0	1.0	8.0	4.0
7	16:35	16:50		18:31	9.0	1.0	8.0	4.0
8	16:52	17:08		18:35	8.4	1.0	7.4	3.5
9	17:08	17:23		18:27	8.4	1.0	7.4	3.5
10	17:24	17:39		18:22	8.4	1.0	7.4	3.5
G6-6	16:10	16:25		19:00	10.9	1.0	9.9	5.0
7	16:25	16:40		18:56	12.7	1.0	11.7	5.5
8	16:40	16:55		18:53	8.6	1.0	7.6	4.0
9	16:55	17:10		18:49	8.6	1.0	7.6	4.0
10	17:10	17:25		18:46	8.6	1.0	7.6	4.0
				B-10				

Potentiometer Recorder wired in parallel with H.P. DVM. At the three grab bag readings the zero gas showed 4.6 mv instead of 1.0. V. was turned up and putting out a 4.0 mv potential. Recorder cleared. No more information could be obtained. B-10

GRAB SAMPLE ANALYSIS

DATE 6/30/73 STATION NO. G1-4

LOCATION ATLANTA ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasberry

PRE GAME SAMPLES

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G1-1	17:00	17:15	15'	20:21	2.7	1.0	1.7	1.0
2	17:15	17:30		20:16	3.0	1.0	2.0	1.0
3	17:30	17:45		20:02	3.4	1.0	2.4	1.0
4	17:45	18:00		20:07	3.1	1.0	2.1	1.0
5	18:00	18:15		20.12	2.6	1.0	1.6	1.0
G2-1	1700	1715		19:32	3.4	1.0	2.4	1.0
2	1715	1730	15	1915	3.5	1.0	2.5	1.5
3	1730	1735	15	1923	3.9	1.0	2.9	1.5
4	1745	1800	15 min	1910	3.3	1.0	2.3	1.0
5	1800	1815	15	1919	3.4	1.0	2.4	1.0
G3-1	17:00	17:15		19:58	3.3	1.0	2.3	1.0
2	1715	1730		19:38	4.3	1.0	3.3	1.5
3	17:30	18:00		19:53	4.3	1.0	3.3	1.5
4	17:45	18:00		19:49	3.9	1.0	2.9	1.5
5	18:00	18:15	15'	19:45	3.3	1.0	2.3	1.0
~~G4-1~~	~~17:00~~	~~17:15~~		~~18:48~~	~~3.7~~	~~1.0~~	~~1.7~~	~~1.0~~
2	17:15	17:30		18:39	2.4	1.0	1.4	0.5
3	17:30	17:45		~~18:43~~	2.3	1.0	1.3	0.5
4	~~17:45~~	18:00		18:35	2.1	~~1.0~~	1.1	0.5
5	~~18:00~~	~~18:15~~		~~18:31~~	~~3.4~~	~~1.0~~	~~2.4~~	~~1.5~~
ZERO BASELINE SHIFTED Refrigeration unit NOT ON								
G4-1	17:00	17:15	15'	18:48	-3.7	-6.0	2.3	1.0
2	17:15	17:30		18:39	-2.4	-6.0	3.6	2.0
3	17:30	17:45		18:43	-2.3	-6.0	3.7	2.0
4	17:45	18:00		18:35	-2.1	-6.0	3.9	2.0
5	18:00	18:15	15'	18:31	-3.9	-6.0	2.1	1.0

GRAB SAMPLE ANALYSIS

DATE 6/30/73 STATION NO. G1-4

LOCATION ATLANTA ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasberry

POST GAME SAMPLES ATTENDANCE 19,333

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G1-6	20:55	21:10	15'	21:47	6.1	1.0	5.1	2.5
7	21:10	21:25		22:00	7.8	1.0	6.8	3.5
8	21:25	21:40		22:52	12.6	1.0	11.6	6.0
9	21:40	21:55		22:17	11.1	1.0	10.1	5.0
10	21:55	22:10	15'	22:12	10.0	1.0	9.0	4.5
G2-6	20:55	21:10	15'	22:04	9.2	1.0	8.2	4.0
7	21:10	21:25		22:08	10.9	1.0	9.9	5.0
8	21:25	21:40		22:25	18.3	1.0	17.3	8.5
9	21:40	21:55		22:38	10.7	1.0	9.7	5.0
10	21:55	22:10	15'	22:20	10.8	1.0	9.8	5.0
G3-6	20:55	21:10	15'	22:53	10.0	1.0	9.0	4.5
7	21:10	21:25		22:57	10.3	1.0	9.3	4.5
8	21:25	21:40		23:01	14.1	1.0	13.1	6.5
9	21:40	21:55		23:08	10.1	1.0	9.1	4.5
10	21:55	22:10	15'	23:09	9.9	1.0	8.9	4.5
G4-6	21:00	21:15	15'	22:47	10.8	1.0	9.8	5.0
7	21:15	21:30		22:44	10.3	1.0	9.3	4.5
8	21:35	21:50		22:39	11.2	1.0	10.2	5.0
9	21:50	22:05		22:50	10.8	1.0	9.8	5.0
10	22:05	22:20	15'	22:35	9.9	1.0	8.9	4.5

GRAB SAMPLE ANALYSIS

DATE 7/1/73 STATION NO. G1-4

LOCATION ATLANTA ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasberry

: Game Samples
ouble Header)

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G1 - 1	12:35	12:50	15'	15:28	3.4	1.0	2.4	1.0
2	12:50	13:05		15:14	3.6	1.0	2.6	1.5
3	13:05	13:20		15:18	3.1	1.0	2.1	1.0
4	13:20	13:35		15:22	3.1	1.0	2.1	1.0
5	13:35	13:50		15:07	2.4	1.0	1.4	1.0
6	16:30	16:45	15'	17:07	3.0	1.4	1.6	1.0
G2 - 1	12:35	12:50	15'	14:24	3.2	1.0	1.2	0.5
2	12:50	13:05		14:18	3.6	1.0	2.6	1.5
3	1305	1320		14:14	4.0	1.0	3.0	1.5
4	1320	1335		14:09	3.0	1.0	2.0	1.0
5	1335	1350		14:04	2.6	1.0	1.6	1.0
6	1630	1645	15'	16:55	3.8	1.4	2.4	1.0
G3- 1	12:32	12:47	15'	15:05	3.0	1.0	2.0	1.0
2	12:47	13:02		1448	3.0	1.0	2.0	1.0
3	13:02	13:17		1452	3.7	1.0	2.7	1.5
4	13:17	13:32		14:57	3.1	1.0	2.1	1.0
5	13:32	13:47		16:01	2.7	1.0	1.7	1.0
6	16:30	16:45	15'	17:15	3.8	1.4	2.4	1.0
G4 - 1	12:35	12:50	15'	14:43	3.0	1.0	2.0	1.0
2	12:50	13:05		14:36	3.4	1.0	2.0	1.0
3	13:05	13:20		14:32	3.0	1.0	2.0	1.0
4	13:22	13:37		14:36	2.3	1.0	1.3	0.5
5	13:37	13:52		14:28	3.0	1.0	2.0	1.0
6	16:25	16:40	15'	17:11	3.9	1.4	2.5	1.0

GRAB SAMPLE ANALYSIS

DATE 7/1/73 STATION NO. G1-4

LOCATION ATLANTA ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasbury

ATTENDANCE 18,450

ouble Header

ST GAME SAMPLES

SAMPLE NO.	COLLECTION TIME OF START	COLLECTION TIME OF FINISH	COLLECTION DURATION OF SAMPLE	ANALYSIS TIME OF ANALYSIS	ANALYSIS METER READING	ANALYSIS BASELINE READING	ANALYSIS DIFFERENCE	ANALYSIS PPM
G1-7	20:23	20:38	15'	21:20	6.8	1.0	5.8	3.0
8	20:38	20:53	)	21:30	7.1	1.0	6.1	3.0
9	20:53	20:68	)	21:25	5.9	1.0	4.9	2.5
10	21:08	21:23	(	21:47	5.5	1.0	4.5	2.5
11	21:23	21:38	15'	21:5	7.2	1.0	6.2	3.0
G2-7	20:23	20:53	30'	21:35	5.9	1.0	4.9	2.5
8	20:38	20:53	20'	21:39	7.1	1.0	6.1	3.0
9	20:53	20:68	15'	21:43	6.7	1.0	5.7	3.0
10	21:08	21:23	15'	22:02	5.7	1.0	4.7	3.0
11	21:23	21:38	15'	21:57	9.4	1.0	8.4	4.0
G3-7	20:20	20:35	15'	22:08	7.6	1.0	6.6	3.5
8	20:35	20:50	)	22:12	8.0	1.0	7.0	3.5
9	20:50	21:05	)	22:19	8.9	1.0	7.9	4.0
10	21:05	21:20	(	22:15	11.7	1.0	10.7	5.5
11	21:20	21:35	15'	22:23	17.0	1.0	16.0	8.0
G4-7	20:13	20:28	15'	22:31	7.8	1.0	6.8	3.5
8	20:29	20:44	)	22:44	8.8	1.0	7.8	4.0
9	20:44	21:00	)	22:39	7.3	1.0	6.3	3.0
10	21:00	21:15	(	22:35	9.6	1.0	8.6	4.5
11	21:15	21:30	15'	22:27	15.3	1.0	14.3	7.0

GRAB SAMPLE ANALYSIS

DATE 7/2/73 STATION NO. G1-4

LOCATION ATLANTA ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasberry

Pre Game Samples

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G1- 1	19:05	19:20	15'	21:00	6.9	1.0	5.9	3.0
2	19:20	19:35			7.0	1.0	6.0	3.0
3	19:35	19:50			7.4	1.0	6.4	3.0
4	19:50	20:05			10.4	1.0	9.4	4.5
5	20:05	20:20	15'	21:15	9.6	1.0	8.6	4.5
G2- 1	19:05	19:20	15'	21:45	7.0	1.0	6.0	3.0
2	19:20	19:35		21:36	7.4	1.0	6.4	3.0
3	19:35	19:50		21:32	7.2	1.0	6.2	3.0
4	19:50	20:05		21:37	9.4	1.0	8.4	4.0
5	20:05	20:20	15'	21:28	11.0	1.0	10.0	5.0
G3- 1	19:00	19:15	15'	20:40	8.4	1.0	7.4	3.5
2	19:15	19:30			8.0	1.0	7.0	3.5
3	19:30	19:45			7.2	1.0	6.2	3.0
4	19:45	20:00			11.4	1.0	10.4	5.0
5	20:00	2015	15'	21:00	12.6	1.0	11.6	6.0
G4- 1	19:05	19:20	15'	22:15	7.8	1.0	6.8	3.5
2	19:20	19:35		22:00	6.9	1.0	5.9	3.0
3	19:36	19:51		22:04	8.9	1.0	7.9	4.0
4	19:51	20:06		22:09	10.7	1.0	9.7	5.0
5	20:07	20:22	15'	21:55	10.6	1.0	9.6	5.0

GRAB SAMPLE ANALYSIS

DATE 7/2/73 STATION NO. G1-4

LOCATION ATLANTA ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasberry

POST GAME SAMPLES ATTENDANCE 6950

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G1-6	22:55	23:10	15'	23:58	13.2	1.0	12.2	6.0
7	23:10	23:25		00:06	14.4	1.0	13.4	6.5
8	23:25	23:40		00:02	15.3	1.0	14.3	7.0
9	23:40	23:55		00:30	11.6	1.0	10.6	5.5
10	23:55	00:10	15'	00:26	12.6	1.0	11.6	6.0
G2-6	23:00	23:15	15'	00:13	11.4	1.0	10.4	5.0
7	23:15	23:30		00:06	11.6	1.0	10.6	5.5
8	23:30	23:45		00:11	15.0	1.0	14.0	7.0
9	23:45	24:00		00:17	10.7	1.0	9.7	5.0
10	24:00	00:15	15'	00:22	15.1	1.0	14.1	7.0
G3-6	23:00	23:15	15'	00:36	12.0	1.0	11.0	5.5
7	23:15	23:30		00:39	10.6	1.0	9.6	5.0
8	23:30	23:45		00:43	11.6	1.0	10.6	5.5
9	23:45	24:00		00:47	17.7	1.0	16.7	8.5
10	24:00	00:15	15'	00:50	15.6	1.0	14.6	7.5
G4-6	23:05	23:20	15'	01:10	13.8	1.0	12.8	6.5
7	23:20	23:25		01:05	12.4	1.0	11.4	5.5
8	23:35	23:50		01:01	11.3	1.0	10.3	5.0
9	23:50	00:05		00:57	13.1	1.0	12.1	6.0
10	00:05	00:20	15'	00:54	12.8	1.0	10.8	5.5

GRAB SAMPLE ANALYSIS

DATE 7/3/73 STATION NO. G5-8

LOCATION ATLANTA ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasberry

Pre Game Samples 22,894

(Fireworks Night)

	COLLECTION			ANALYSIS				
					(MV)			
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G5-1	19:05	19:20	15'	21:06	10.4	1.0	9.4	4.5
2	19:20	19:35		20:57	5.0	1.0	4.0	2.0
3	19:35	19:50		20:53	7.3	1.0	6.3	3.5
4	19:50	20:05		21:01	4.2	1.0	3.2	1.5
5	20:05	20:20	15'	20:49	6.2	1.0	5.2	2.5
G6-1	19:05	1920	15'	21:20	8.6	1.0	7.6	4.0
2	~~1920~~	~~1935~~		21:15	17.6	1.0	16.6	8.5
3	19:35	19:50		21:18	7.2	1.0	6.3	3.0
4	19:50	20:05		21:27	9.1	1.0	8.4	4.0
5	20:05	20:20	15'	21:23	23.4	1.0	22.4	11.0
G7-1	1900	1915	15'	20:30	16.9	1.0	15.9	8.0
2	1915	1930		20:34	8.9	1.0	7.9	4.0
3	1930	1945		20:37	13.6	1.0	12.6	6.5
4	19:45	20:00		20:45	9.0	1.0	8.0	4.0
5	20:00	20:15	15'	20:41	12.2	1.0	11.2	5.5
G8-1	19:05	19:20	15'	21:45	6.2	1.0	5.2	2.5
2	19:20	19:35		21:41	7.6	1.0	6.6	3.5
3	19:35	19:50		21:49	15.6	1.0	14.6	7.5
4	19:50	20:05		21:34	11.6	1.0	10.6	5.5
5	20:05	20:20	15'	21:37	15.8	1.0	14.8	7.5

CI 1900-2000 = 4.0

WIND 1900 N/5

2000 N/4

GRAB SAMPLE ANALYSIS

DATE 7/3/73 STATION NO. G5-8

LOCATION ATLANTA ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasbery

POST GAME SAMPLES (Fireworks Night)

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G5-6	23:00	23:15	15'	01:29	30.4	1.0	29.4	14.5
7	23:15	23:30		01:21	74.2	1.0	73.2	36.5
8	23:30	23:45		01:25	61.8	1.0	60.8	30.5
9	23:45	24:00		01:17	44.4	1.0	43.4	21.5
10	24:00	00:15	15'	01:13	25.2	1.0	24.2	12.0
G6-6	23:00	23:15	15'	00:54	12.1	1.0	11.1	5.5
7	23:15	23:30		00:43	31.0	1.0	30.0	15.0
8	23:30	23:45		00:40	32.4	1.0	31.4	15.5
9	23:45	24:00		00:47	12.9	1.0	11.9	6.0
10	24:00	00:15	15'	00:50	10.2	1.0	9.2	4.5
G7-6	22:55	23:10	15'	01:10	14.4	1.0	13.4	6.5
7	23:10	23:25		00:56	42.4	1.0	41.4	20.5
8	23:25	23:40		00:59	102.4	1.0	101.4	50.5
9	23:40	23:55		01:07	42.2	1.0	41.2	20.5
10	23:55	00:10	15'	01:09	9.0	1.0	8.0	4.5
G8-6	23:00	23:15	15'	00:38	11.1	1.0	10.1	5.0
7	23:15	23:30		00:27	16.6	1.0	15.6	8.0
8	23:30	23:45		00:23	13.9	1.0	12.9	6.5
9	23:45	24:00		00:34	9.6	1.0	8.6	4.5
10	24:00	00:15	15'	00:31	7.7	1.0	6.7	3.5

GRAB SAMPLE ANALYSIS

DATE 7/4/73 STATION NO. 65-8

LOCATION ATLANTA ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasberry

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G5- 1	17:00	17:15	15'	19:47	21.2	1.0	20.2	10.0
2	17:15	17:30		19:34	37.6	1.0	36.6	13.5
3	17:30	17:45		19:37	19.4	1.0	18.4	9.0
4	17:45	18:00		19:30	16.0	1.0	15.0	7.5
5	18:00	18:15		19:42	11.8	1.0	10.8	5.5
6	20:47	21:02	15'	21:30	5.4	1.0	4.4	2.2
G6- 1	17:00	17:15	15'	19:25	4.7	1.0	3.7	2.0
2	17:15	17:30		19:22	7.1	1.0	6.1	3.0
3	17:30	17:45		19:19	6.8	1.0	5.8	3.0
4	17:45	18:00		19:15	4.0	1.0	3.0	1.5
5	18:00	18:15		19:27	4.8	1.0	3.8	2.0
6	20:42	20:57	15'	21:18	4.4	1.0	3.4	1.5
G7- 1	17:00	17:15	15'	19:07	12.6	1.0	11.6	6.0
2	17:15	17:30		19:03	10.1	1.0	9.1	4.5
3	17:30	17:45		18:55	5.1	1.0	4.1	2.0
4	17:45	18:00		18:58	4.6	1.0	3.6	2.0
5	18:00	18:15		19:02	5.0	1.0	4.0	2.0
6	20:50	21:05	15'	21:17	6.0	1.0	5.0	2.5
G8- 1	17:00	17:15	15'	18:48	7.0	1.0	6.0	3.0
2	17:15	17:30		18:37	7.9	1.0	6.9	3.5
3	17:30	17:45		18:41	6.9	1.0	5.9	3.0
4	17:45	18:00		18:45	8.6	1.0	7.6	4.0
5	18:00	18:15		18:51	6.4	1.0	5.4	2.5
6	20:55	21:10	15'	21:42	6.4	1.0	5.4	2.5

N
NNW

CI 1700-1800 = 2.0
WIND 1700 NNW/3
1800 WSW/5

GRAB SAMPLE ANALYSIS

DATE 4 JULY 1973 STATION NO. G5-8

LOCATION ATLANTA ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rooberry

POST GAME SAMPLES ATTENDING 13,500

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G 5-7	00:00	00:15	15'	00:14	20.3	1.0	19.3	9.5
8	00:15	00:30		00:54	44.2	1.0	43.2	21.5
9	00:30	00:45		00:32	11.4	1.0	10.4	5.0
10	00:45	01:00		01:34	8.0	1.0	7.0	3.5
11	~~01:00~~ 00:10	01:15	15'	01:28	9.0	1.0	8.0	4.0
G-6 7	00:05	00:20	15'	01:05	25.3	1.0	24.3	12.0
8	00:20	00:35		01:08	15.7	1.0	14.7	7.5
9	00:35	00:50		01:39	7.0	1.0	6.0	3.0
10	00:50	01:05		01:37	6.0	1.0	5.0	2.5
11	01:05	01:20	15'	01:41	4.4	1.0	3.4	1.5
G-7 7	00:05	00:20	15'	01:11	17.9	1.0	16.9	8.5
8	00:20	00:35		01:28	9.3	1.0	8.3	4.0
9	00:35	00:50		01:44	5.7	1.0	4.7	2.5
10	00:50	01:05		01:48	3.4	1.0	2.4	1.0
11	~~00~~ 01:05	01:20	15'	01:45	3.4	1.0	2.4	1.0
G-8 7	~~00~~:10	00:25	15'	00:50	8.2	1.0	7.2	3.5
8	00:25	00:40		01:02	8.6	1.0	7.6	4.0
9	~~00~~:40	00:55		00:58	7.2	1.0	6.2	3.0
10	00:55	01:00		01:24	4.1	1.0	3.1	1.5
11	01:10	01:25	15'	01:22	3.7	1.0	2.7	1.5

GRAB SAMPLE ANALYSIS

DATE 7/5/73 STATION NO. 65-8

LOCATION ATLANTA ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasberry

Pre Game Samples

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G5-1	19:00	19:15	15'	20:52	7.9	1.0	6.9	4.0
2	19:15	19:30		20:47	10.2	1.0	9.2	4.5
3	19:30	19:45		20:50	12.4	1.0	11.4	5.5
4	19:45	20:00		20:44	10.8	1.0	9.8	4.0
5	20:00	20:15	15'	20:40	6.2	1.0	5.2	2.5
~~G6~~								
G6-1	19:05	19:20	15'	21:04	4.0	1.0	3.0	1.5
2	19:20	19:35		20:57	3.6	1.0	2.6	1.5
3	19:35	19:50		21:02	3.7	1.0	2.7	1.5
4	19:50	20:05		20:54	3.8	1.0	2.8	1.5
5	20:05	20:20	15'	20:59	4.2	1.0	3.2	1.5
G7-1	19:00	19:15	15'	~~21:06~~ 21:20	11.3	1.0	10.8	5.0
2	19:15	19:30		21:06	11.0	1.0	10.0	5.0
3	19:30	19:45		21:13	13.0	1.0	12.0	6.0
4	19:45	20:00		21:10	6.0	1.0	5.0	2.5
5	20:00	20:15	15'	21:08	6.2	1.0	5.2	2.5
G8-1	19:05	19:20	15'	21:26	7.7	1.0	6.7	3.5
2	19:20	19:35		21:16	8.6	1.0	7.6	4.0
3	19:35	19:50		21:22	7.0	1.0	6.0	3.0
4	19:50	20:05		21:28	7.3	1.0	6.3	3.0
5	20:05	2:20	15'	21:24	9.0	1.0	8.0	4.0

CI 1900-2000 = 1.5 ppm

1900 NNW/5

2000 NNW/5

GRAB SAMPLE ANALYSIS

DATE 7/5/73 STATION NO. G5-8

LOCATION ATLANTA ANALYSIS METHOD NDIR

PERSON PERFORMING ANALYSIS Phil Rasbery

POST GAME SAMPLES 5,340

	COLLECTION			ANALYSIS				
SAMPLE NO.	TIME OF START	TIME OF FINISH	DURATION OF SAMPLE	TIME OF ANALYSIS	METER READING	BASELINE READING	DIFFERENCE	PPM
G5-6	22:30	22:45	15'	23:58	44.9	1.0	43.9	22
7	22:45	23:00		23:56	15.6	1.0	14.6	7.5
8	23:00	23:15		23:55	9.2	1.0	8.2	4.0
9	23:15	23:30		23:53	9.7	1.0	8.7	4.5
10	23:30	23:45	15'	23:51	11.1	1.0	10.1	5.0
G6-6	22:35	22:50	15'	23:28	13.6	1.0	12.6	6.5
7	22:50	23:05		23:44	10.1	1.0	9.1	4.5
8	23:05	23:20		23:41	10.0	1.0	9.0	4.5
9	22:20	22:35		00:09	9.0	1.0	8.0	4.0
10	23:50	00:05	15'	00:10	8.8	1.0	7.8	4.0
G7-6	22:35	22:50	15'	23:34	41.6	1.0	40.6	20.5
7	22:50	23:05		23:29	28.7	1.0	27.7	19
8	23:05	23:20		00:02	11.4	1.0	10.4	5.0
9	23:20	23:35		24:00	11.0	1.0	10.0	5.0
10	23:35	23:50	15'	23:57	11.7	1.0	10.7	5.0
G8-6	22:45	23:00	15'	23:36	17.0	1.0	16.0	8.0
7	23:00	23:15		23:32	16.0	1.0	15.0	7.5
8	23:15	23:30		23:39	12.4	1.0	11.4	5.5
9	23:30	23:45		00:03	10.7	1.0	9.7	4.5
10	23:45	24:00	15'	00:06	11.2	1.0	10.2	5.0

APPENDIX C

FIELD CALIBRATION FORMS

CO INSTRUMENT DAILY CHECK SHEET

STATION NAME GRAB BAGS LOCATION PITTSBURGH DODGE VAN

SAMPLE ROTAMETER SETTING _____ REFERENCE ROTAMETER SETTING 3.0

ZERO BASELINE (% RECORDER CHART) 0+.25 PPM "0" Gas = 1.0

SPAN (% RECORDER CHART) 50

CALIBRATE ADJUST SETTING _____ OPERATOR _____

DATE	FLOW READING		INST. CHECKS					DIGITAL VOLTMETER READINGS (mV) UNADJ. CALIB.		~~NEW KNOB~~ POS.		CYL. PRESS	
	SAMPLE	REF	1	2	3	4	5	ZERO	SPAN	ZERO	SPAN	ZERO	SPAN
6/21/73 10:00	3.0		INITIAL					CALIBRATION					
6/21/73 20:00	"							0.9 / 0.8	50.0 / 50.0				
6-22-73 0200	"							1.3 / 1.3	~~50.2~~ / 50.2				
6-22-73 19:15	"							0.5 / 1.0	50.6 / 50.3				
6-23-73 01:19	"							1.5 / 0.8	50.8 / 49.6				
6-23-73 16:00	"							0.6 / 0.9	49.8 / 50.0				
6-24-73 00:35	"							1.3 / 1.2	50.4 / 50.9				
6-24-73 12:00	"		252					1.1 / 1.0	50.5 / 50.4				
6-24-73 19:30	"							1.3	51.0				
								END OF RUN					

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UNADJUSTED
ADJUSTED

CO INSTRUMENT DAILY CHECK SHEET

STATION NAME GRAB BAGS LOCATION ATLANTA

SAMPLE ROTAMETER SETTING X REFERENCE ROTAMETER SETTING X

ZERO BASELINE (% RECORDER CHART) 1.0

SPAN (% RECORDER CHART) 50

CALIBRATE ADJUST SETTING X OPERATOR

DIGITAL VOLTMETER READING (mv)

	DATE	FLOW READING SAMPLE	FLOW READING REF	INST. CHECKS 1	2	3 X	4	5	UNADJ. CALIB. ZERO	UNADJ. CALIB. SPAN	NEW KNOB POS. ZERO	NEW KNOB POS. SPAN	CYL. PRESS ZERO	CYL. PRESS SPAN
J	6/29/73 17:35	3.0		Initial Calibration							55	50		
J	6/30/73 15:35	3.0							1.0	50.4	55	50		
Jul	6/30/73 23:10	3.0							0.6 / 1.0	49.9 / —	60	43		
Jul	7/1/73 12:55	3.0							1.8 / 1.0	50.3 / 50.3	60	43		
Jul	7/1/73 23:45	3.0							0.6 / 0.6	50.6 / 50.6	60	43		
Jul	7/1/73 20:65	3.0							1.1 / 1.1	50.5 / 50.5	60	42.5		
Jul	7/3/73 01:30	3.0							0.8	50.1	60	42.5		
Jul	7/3/73 20:20	3.0							1.0	50.2	60	42.5		
Jul	7/4/73 01:33	3.0							1.1	50.7	60	42.5		
Jul	7/4/73 18:33	3.0							0.9	50.2	60	42		
Jul	7/5/73 01:55	3.0							0.6	49.6	60	42		
Jul	7/5 73 20:30	3.0							1.0	50.0	60	41		
Jul	7/6/73 00:15	3.0							1.1	50.1	60	41		

UNADJUSTED
ADJUSTED

CONTINUOUS

CO INSTRUMENT DAILY CHECK SHEET

STATION NAME MOBILE VAN ; C1 LOCATION PITTSBURGH; C1

SAMPLE ROTAMETER SETTING 3.0 REFERENCE ROTAMETER SETTING 3.0

ZERO BASELINE (% RECORDER CHART) 6

SPAN (% RECORDER CHART) 56

CALIBRATE ADJUST SETTING _____ OPERATOR BATCH/ RASBERRY

DATE	FLOW READING		INST. CHECKS					UNADJ. CALIB.		NEW KNOB POS.		CYL. PRESS	
	SAMPLE	REF	1	2	3	4	5	ZERO	SPAN	ZERO	SPAN	ZERO	SPAN
1600 6/20	3.0		250	X				3.0	57.0	74	47	2025	1950
6/21 0915	3.0		250	X				5	56	75	47	1925	1875
6/22/73 1600	3.1		250	X				6	56	75	47	1800	1800
6/23/73 1300	2.7		250	X				6	56	75	47	1790	1750
6/24/73 1120	3.1		250	X				6	56	75	47	1750	1750
6/25/73	3.0		250	X				6.0	56	N/A; Shut-Down		1700	1725

1155 WOG

CO INSTRUMENT DAILY CHECK SHEET

STATION NAME Stadium EAST; C2 LOCATION Pittsburgh; C2

SAMPLE ROTAMETER SETTING 3.0 REFERENCE ROTAMETER SETTING 3.0

ZERO BASELINE (% RECORDER CHART) 6

SPAN (% RECORDER CHART) 57

CALIBRATE ADJUST SETTING _____ OPERATOR Bolu / Prissanan

	DATE	FLOW READING		INST. CHECKS					UNADJ. CALIB.		NEW KNOB POS.		CYL. PRESS		
		SAMPLE	REF	1	2	3	4	5	ZERO	SPAN	ZERO	SPAN	ZERO	SPAN	
DB	1735 6/20	3.0	3.0	250	no				5.1	56.0	74	69	2000	1990	815 no!
DB	0955 6/21	3.3	3.0	250	no				4.5	55.5	79	69	1950	1975	
	1400 6/22	3.4	3.0	250	no				3.5	52.5	81	72	1925	1925	150 no
	1205 6/23	3.7	3.0	250	no				4.5	530	82	75	1875	1900	
VC	1115 6/24	5.0		250	no				5.0	53.0	82	79	1850	1875	131 Bar
	955 6/25	4.5		250	no				6.0	54.0	N/A Instr. Comm. Prob.	N/A, Instr Comm, Prob	1850	1850	9.2 Bar

CO INSTRUMENT DAILY CHECK SHEET

STATION NAME Stanwix EAST; C2 LOCATION Pittsburgh; C2

SAMPLE ROTAMETER SETTING 3.0 REFERENCE ROTAMETER SETTING 3.0

ZERO BASELINE (% RECORDER CHART) 6

SPAN (% RECORDER CHART) 57

CALIBRATE ADJUST SETTING _____ OPERATOR Bolin / Crissman

DATE	FLOW READING SAMPLE	FLOW READING REF	INST. CHECKS 1	2	3	4	5	UNADJ. CALIB. ZERO	UNADJ. CALIB. SPAN	NEW KNOB POS. ZERO	NEW KNOB POS. SPAN	CYL. PRESS ZERO	CYL. PRESS SPAN	
1735 6/20	3.0	3.0	250	no				5.1	56.0	78	69	2000	1990	815 cal
0955 6/21	3.3	3.0	250	no				4.5	55.5	79	69	1950	1975	
1400 6/22	3.4	3.0	250	no				3.5	52.5	81	72	1925	1925	150 cal
1205 6/23	3.7	3.0	250	no				4.5	53.0	82	75	1875	1900	
1115 6/24	5.0		250	no				5.0	53.0	82	79	1850	1875	121 cal
955 6/25	4.5		250	no				6.0	54.0	N/A shut down, P.M.	N/A, shut down, P.M.	1850	1850	9:2 cal

CO INSTRUMENT DAILY CHECK SHEET

STATION NAME Stadium Trailer West; C3 LOCATION Pittsburgh, PA

SAMPLE ROTAMETER SETTING 3.0 REFERENCE ROTAMETER SETTING 3.0

ZERO BASELINE (% RECORDER CHART) 6

SPAN (% RECORDER CHART) 57

CALIBRATE ADJUST SETTING _____ OPERATOR Bach/Crissman/Lazzery

	DATE	FLOW READING SAMPLE	FLOW READING REF	INST. CHECKS 1	2	3	4	5	UNADJ. CALIB. ZERO	UNADJ. CALIB. SPAN	NEW KNOB POS. ZERO	NEW KNOB POS. SPAN	CYL. PRESS ZERO	CYL. PRESS SPAN	
XB	1115 6/21	3.9		250	no				4.0	56.5	19	90	1900	1825	WR 122
Phil	14:37 6/22/73	3.3		25.0	NO				6.0	57.0	19	89	REGULATOR CHANGED 1880	1780	Phil 15:
JC	14:07 6/23/73	3.0		25.0	No				6.0	57.0	19	89	1850	1825	Bike 150
Phil	11:05 6/24/73	3.0		25.0	X				6.0	57.0	19	89	1825	1775	Phil
Phil	08:45 6/25/73	2.9		25.0	X				N/A Shut-down in Pittsburgh						

CO INSTRUMENT DAILY CHECK SHEET

STATION NAME ATLANTA CENTRAL LOCATION ATLANTA; C1

SAMPLE ROTAMETER SETTING 3.0 REFERENCE ROTAMETER SETTING 3.0

ZERO BASELINE (% RECORDER CHART) 6

SPAN (% RECORDER CHART) 56

CALIBRATE ADJUST SETTING _____ OPERATOR BACH

DATE	FLOW READING		INST. CHECKS					UNADJ. CALIB.		NEW KNOB POS.		CYL. PRESS	
	SAMPLE	REF	1	2	3	4	5	ZERO	SPAN	ZERO	SPAN	ZERO	SPAN
6/29 1700	3.0							6	57	77	55		
6/30 1000	2.9		250	NO				5.0	58	78	48	1525	1525
7/1 1030	2.9		250	~				6.0	57	78/78	48/48	1500	1500
7/2/73 11:40	2.8		✓	X				6.0	56	78	48	1375	1475
7/3/73 1545	3.0		250	NO				6.0	56	78	48	1850	1950
7/4/73 12:35	3.0		✓	X				5.0	55.5	78	48	1300	1900
7/5/73 13:20	3.0		✓	X				6.0	57.0	78	48	1275	1375
WDS 7/6/73 10:30	3.1		250	X				6.0	57.0				

CO INSTRUMENT DAILY CHECK SHEET

STATION NAME STADIUM TRAILER #1 (N.E.) LOCATION ATLANTA; GA

SAMPLE ROTAMETER SETTING 3.0 REFERENCE ROTAMETER SETTING 3.0

ZERO BASELINE (% RECORDER CHART) 6

SPAN (% RECORDER CHART) 57

CALIBRATE ADJUST SETTING _____ OPERATOR Mitchell/Bessman/Gaberly

DATE	FLOW READING SAMPLE	FLOW READING REF	INST. CHECKS 1	2	3	4	5	UNADJ. CALIB. ZERO	UNADJ. CALIB. SPAN	NEW KNOB POS. ZERO	NEW KNOB POS. SPAN	CYL. PRESS ZERO	CYL. PRESS SPAN	
6/28/73 PM	Turn Instrument ON													UNIT #1
6/29/73 1230	Initial Calibration									90	74	1790	1800	
6/30/73 09:45	3.5							Varys 6 to 3	varys from 57 to 60	CHANGED INSTRUMENT				
#6														
6/30/73 12:50	3.0	INITIAL CALIBRATION						6	57	8.5	85.5	1500	1730	
7/1/73 11:40	3.1		250	NO				11	65	6.0	80.0	1600	1700	ABB
7/2/73 12:05	2.9		250	NO				7.0	59.0	5.0	80.0	1575	1725	WB
7/2/73 13:43	7.2		250	Yes				12.0	62.0	2.0	80.0	1500	1675	
7/4/73 1500	2.5		25	No				6.0	58.0	2.0	77	1475	1675	ABB
7/5/73 1210	3.0		25	No				10.0	62	9.0	73			
	(ZERO POSITION SHIFTED TO 10 mv reactivity)													
7/6/73	2.6		✓	X				10.0	62	END OF DATA				
#1 1545 7/2/73	3.0	20 PSI	250	NO						38	75	1600	1725	
ABB 7/3/73 1202	5.9		250	No.				UNSTABLE UNABLE TO ZERO		31	70	1500	1675	
7/4/73 1500	4.0		250	No				?	46	40	74			
	N.B.	Instrument appears to						have	drift	Panel meter &		strip chart		CO
7/5/73 1210	3.4		250	NO				7	60					
		UNIT SHUT DOWN						1300						

650 KWH Consumed on #1 AT ATLANTA

CO INSTRUMENT DAILY CHECK SHEET

STATION NAME Atlanta Southwest #5 LOCATION I-85/Ant. C3

SAMPLE ROTAMETER SETTING 3.0 REFERENCE ROTAMETER SETTING 3.0

ZERO BASELINE (% RECORDER CHART) 6.0

SPAN (% RECORDER CHART) 57.0

CALIBRATE ADJUST SETTING _____ OPERATOR Rasberry/Prisson

	DATE	FLOW READING		INST. CHECKS					UNADJ. CALIB.		NEW KNOB POS.		CYL. PRESS	
		SAMPLE	REF	1	2	3	4	5	ZERO	SPAN	ZERO	SPAN	ZERO	SPAN
	6/30 1330	30									56	45	1950	1700
Field	7/1/73 10.00	4.2		✓	X				7	57	56	42	1575	1600
Field	7/2/73 12.30	3.5		✓	X				7.5	57.5	55.5	43.5	1425	1550
Field	7/3/73 11:00	3.8		✓	X				12.0	64	51.0	42.0	1425	1525
Cal	7/4/73 11:30	3.7		✓	X				7	58	50.0	42.0	1400	1500
Field	7/5/73 10:45	3.8		✓	X				5.5	65	50	42	1300	1475
Cal	7/6/73 10:00	3.5		25	00				5.0	56.5	—	—	1275	1475

CO INSTRUMENT DAILY CHECK SHEET

STATION NAME Atlanta South West Unit II LOCATION Atlanta; C3

SAMPLE ROTAMETER SETTING 3.0 REFERENCE ROTAMETER SETTING 3.0

ZERO BASELINE (% RECORDER CHART) 6.0

SPAN (% RECORDER CHART) 57.0

CALIBRATE ADJUST SETTING _____ OPERATOR Lafferty

	DATE	FLOW READING SAMPLE	FLOW READING REF	INST. CHECKS 1	2	3	4	5	UNADJ. CALIB. ZERO	UNADJ. CALIB. SPAN	NEW KNOB POS. ZERO	NEW KNOB POS. SPAN	CYL. PRESS ZERO	CYL. PRESS SPAN
wil	6/28/73	DM	Turn	on	Equip	ment								
wil	6/29/73	16:30	Initial	Calibration							81	77	1800	1725
	1200 6/30	48	30	✓	✓				3.8	54	82	78	1760	1725
wil	7/1/73 10:35	3.3		✓	X				5.0	53	82	83	1575	1600
Phil	7/2/73 13:05	3.6		✓	X				4.5	51	82	97	1225	1550
Phil	~~7/3/73 11:00~~	~~3.4~~		✓	X				12.0	64	5	(units)		
		Unit found to function erratically.												

APPENDIX D

INSTRUMENT DRIFT STATISTICS

TABLE D1. Zero and span 24-hour drift statistics for CO analyzers. The numbers under Span and Zero headings are the drift in ppm in 24 hours. Negative indicates a decrease in the zero or span point.

PITTSBURGH

Date	Unit 1		Unit 2		Unit 3	
	Zero	Span	Zero	Span	Zero	Span
6-21	-1.5	-2.5	0.0	0.0	0.0	0.0
6-22	-1.0	-2.0	0.0	0.0	0.0	0.0
6-23	-0.5	-2.0	0.0	0.0	0.0	0.0
6-24	-1.0	-1.5	-0.5	-0.5	0.0	0.0
Mean	-1.0	-2.0	-0.1	-0.1	0.0	0.0
Standard Deviation	0.4	0.4	0.0	0.0	0.0	0.0

ATLANTA

Date	Unit 5		Unit 6		Unit 3	
	Zero	Span	Zero	Span	Zero	Span
6-30	0.5	0.5	2.5	4.0	0.0	0.0
7-1	0.5	0.0	0.5	1.0	0.0	0.0
7-2	3.0	3.5	3.0	3.0	0.0	0.0
7-3	0.0	0.0	0.0	0.5	-0.5	0.0
7-4	0.0	0.0	2.0	2.5	0.0	0.0
7-5	-0.5	0.0	0.0	0.5	0.0	0.0
Mean	0.6	0.7	1.3	1.9	-1.0	0.0
Standard Deviation	1.1	1.3	1.2	1.3	0.0	0.0

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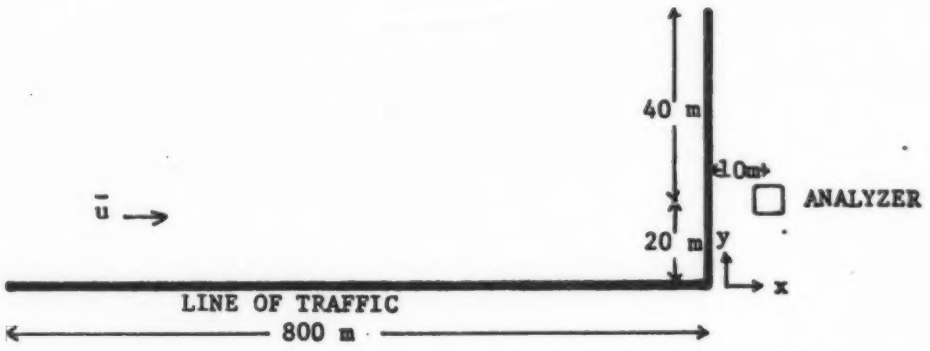
THEORETICAL COMPUTATION OF CO CONCENTRATION FOR TRAFFIC AT PITTSBURGH STADIUM

One of the primary uses of the data collected in this study will be in assessing procedures for estimating CO concentrations about proposed sports complexes. The research team was, thus, motivated to try a simple model comparison with the data. A case was selected in which the prototype situation could be most closely approximated by an analytic model and one in which the best estimates could be made of the model parameters describing the site characteristics.

The prototype situation was that of site C2 in Pittsburgh (see Figure 2) for aftergame traffic moving along North Shore Drive from Allegheny Avenue. The model is shown below.



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CO was assumed to be generated only by cars moving along the heavy line; no contribution from the parking lots was included.

Concentration, χ, from a point source of strength Q is given by

$$\chi = \frac{Q}{2\pi\sigma_y\sigma_z\bar{u}} \exp\{-1/2\,[(\frac{y}{\sigma_y})^2 + (\frac{z-H}{\sigma_z})^2]\} \qquad (E.1)$$

where Q is the point strength in gm/sec, σ_y and σ_z are the standard deviations in the y and z directions respectively of a Gaussian concentration, $\bar{u}$ is the average wind speed, H is the source height and z is measured in the vertical. It was assumed z-H=0 (source and receptor at the same height), σ_z = 4.5m and $\sigma_y(x)$ = .08x corresponding to D class stability. For reflection at the bottom boundary, the source strength must be doubled. Therefore, the concentration from a line source parallel to the wind is given by integrating χ along the line. Assuming Q constant along the line gives

$$\chi_l = \frac{Q}{\bar{u}\pi\sigma_z} \int_{800m}^{10m} \frac{1}{0.08x} \exp\{-1/2\,(\frac{y^2}{.08})^2 \cdot \frac{1}{x^2}\}\,dx\,. \qquad (E.2)$$

Graphically integrating (E.2) for y = 20m (the concentration appropriate to the analyzer location 20m off the centerline) gives

$$\chi_l = \frac{1.58Q}{\bar{u}\pi\sigma_z}$$

or

$$\frac{\chi_l\,\bar{u}}{Q} = .1118/m^2\,. \qquad (E.3)$$

The contribution from the traffic moving perpendicular to the wind is obtained by integrating χ along the line 10m to the left of the analyzer,

$$\chi_{\perp} = \frac{Q}{\bar{u}\pi\sigma_y\sigma_z} \int_{-20m}^{40m} \exp\{-1/2\,(\frac{y}{\sigma_y})^2\}\,dy$$

$$= \frac{Q}{\pi\bar{u}\sigma_z} \int_{p_1}^{p_2} e^{-p^2/2}\,dp \qquad \text{where } p = \frac{y}{\sigma_y}$$

$$\chi_{\perp} = \frac{Q}{\sqrt{\pi}\,\bar{u}\sigma_z}$$

or

$$\frac{\chi_{\perp}\bar{u}}{Q} = .1254/m^2 \tag{E.4}$$

The total concentration at the analyzer is, thus,

$$\chi_T = .2372\,\frac{Q}{\bar{u}}\ \text{gm/m}^3 \tag{E.5}$$

Assuming a 1973 mix of automobiles, the CO emission factor[3] is 80 gm/vehicle mi. If the cars are assumed to be moving at 5 mph the speed adjustment factor[3] is 3.0. If the car spacing is 6m the line source strength is

$$Q = \frac{80\ \text{gm}}{\text{vehicle mi}} \cdot \frac{1\ \text{vehicle}}{6\text{m}} \cdot \frac{1\ \text{mi}}{1.6 \times 10^3\text{m}} \cdot \frac{2.5\text{m}}{\text{sec}} \cdot 3$$

$$= 62.5\ \text{gm/msec}$$

With $\bar{u}$ = 4.5 mph = (2.0 m/sec)

$$\chi_T = 62.5 \frac{gm}{msec} \cdot \frac{1}{2} \frac{sec}{m} \cdot \frac{0.2372}{m} = 7.4 \text{ gm/m}^3$$

or

$$\chi_T = 5.7 \text{ ppm} .$$

Since three lanes of traffic were present (3 × Q)

$$\chi_T = 17.1 \text{ ppm} .$$

This concentration assumes a steady state source contribution. If the source lasted for one hour, the hourly average would be 17.1 ppm. Since the traffic moves out of the stadium area in less than an hour, the hourly average must be less than 17.1 ppm. The constant line source strength based on the maximum emissions along its total length (3 cars every 6m) would also overestimate the hourly average.

If we allow for this by assuming 100% capacity for the 30 minutes directly following the game, 50% capacity for the next 15 minutes and 25% capacity for the next 15 minutes, the hourly average would be

$$\chi_{AVG} = (17.1 \times 2 + 8.5 + 4.3)/4 \text{ ppm}$$

$$= 11.8 \text{ ppm} .$$

CO concentrations, above the background nighttime values, observed at site C2 for the four fifteen minute periods starting at the end of the ballgame were 14.0 ppm, 19.0 ppm, 25.0 ppm and 15.0 ppm giving an hourly average of 18.3 ppm.

The difference between the computed and measured concentrations could be the CO pro ed by vehicles in the parking lots which were not included in the linear source model. This leads to a parking lot contribution to the hourly average of about 6.5 ppm.

On 21 June the attendance was about half that of 23 June (see Table III) and the wind was about the same speed and from the west. Under the same assumptions used for 23 June the computed hourly average CO concentration is 5.9 ppm. The measured values for the four fifteen minute periods starting at the end of the game were 1.0 ppm, 19.5 ppm, 6.0 ppm and 1.0 ppm above the diurnal trend giving an hourly average of 6.9 ppm. This would yield a parking lot contribution to the hourly average of only about 1 ppm.

For 22 June the attendance was about the same as 23 June. All other variables were the same except the wind direction which was from the south instead of the west, i.e. perpendicular to the long traffic line source of the model. The wind direction effect is highlighted if the preceeding calculations are repeated for 22 June and a west wind is assumed as before. The computed hourly average is, thus, the same as for 23 June, 11.8 ppm. The observed average is only 5.6 ppm at site C2 reflecting the effect of the south wind in reducing the concentration at C2.